1987 HAMILTON-WENTWORTH AIR QUALITY

JUNE 1989

Environment Ontario

Jim Bradley
Minister

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WEST CENTRAL REGION

JUNE 1989

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1. SUMMARY

Airborne particulates (dust) and odours have been Hamilton's main air pollution problems over recent years. In 1987, particulate levels remained relatively unchanged, but odours due to reduced sulphur compounds were reduced dramatically.

The Air Pollution Index reached the advisory level of 32 twice in 1987 compared to 5 occasions in 1986.

Although total suspended particulates generally remained unchanged from the previous year, heavy settleable dust was reduced slightly from previous years. However, dustfall still remained well above objectives in the industrial and central area of the city.

The network of fluoride monitors indicated higher concentrations than 1986.

With the exception of reduced sulphur compounds (TRS), gaseous pollutants showed little change. Ozone is one of two gases which continued to exceed criteria. It is a product of long range transport and is produced photochemically to excess during the summer. Highest levels were measured on the "mountain".

Total reduced sulphur concentrations reduced dramatically in the city during 1987. The improvement appears directly related to Stelco Inc. replacing direct contact coolers in the coke oven by-products area with indirect coolers in April 1987, and changes in slag quenching practices. The only place where improvement did not occur was the Beach Blvd. area. Stelco's effect there was limited by distance. Hamilton's other steel company - Dofasco Ltd., and to a lesser extent the Carbochem tar plant, continued to impinge on the Beach.

Total reduced sulphur compounds are a major cause of odours. Negotiations with industry for reductions of these emissions have been completed. Control programs are underway at Stelco, Carbochem (formerly Domtar) and Dofasco. Naphthalene is also an odourous compound and Carbochem's control programs will eliminate these odours.

The Phytotoxicology Section's 1987 survey of silver maple foliage found light amounts of visual injury due to air pollution, but only at three locations close to the industrial complex.

The Air Resources Branch conducted a mobile van survey in the fall of 1987 and found Carbochem to be a significant source of naphthalene and total reduced sulphur compounds sufficient to exceed ambient air quality standards and guidelines. Dofasco, Stelco, Canron and Columbian Chemicals met all standards and guidelines during the survey.

The van survey also conducted city-wide monitoring during an inversion when the API reached 35. The data indicated that the prime source of gaseous contaminants throughout the city during this occasion was vehicle traffic.

Airborne dust measurements near Steetley Industries, a quarry with lime kilns in Flamborough, showed that some improvement in dustfall measurements occurred in 1987 following the installation of a new electrostatic precipitator at the company's processing plant. However, suspended particulate measurements continued to show a localized problem and some dustfall samples were also still above objectives. Further measures are being taken by the company to improve air quality.

2. INTRODUCTION

The Air Management Program in Ontario is based on controlling man- made emissions to meet ambient air quality objectives, which in turn are based on known effects on health, quality of life, sensitive vegetation or materials, whichever is most stringent. To achieve these objectives, sources of pollution are identified, their emissions evaluated and appropriate control measures are instituted. Ambient air monitoring is used to identify pollution sources and to verify that controls have been successful. Monitors are usually sited in areas suspected of experiencing higher levels of air pollution. When these areas achieve acceptable air quality, then it is assumed that other areas should also be acceptable.

3. MONITORING NETWORK

The Ministry of the Environment operates a network of ambient air monitors throughout Hamilton as shown in Figure 1 and Table 1. The network centres on six automated stations which continuously monitor a variety of pollutants and telemeter hourly averaged data to a central computer facility in Toronto. These stations are:

29000 - Elgin/Kelly, downtown
29025 - Barton/Sanford, between downtown & the industrial zone
29102 - Beach Blvd
29105 - Nash/Kentley, in the east end
29114 - Vickers/East 18th, on the mountain
29118 - Main West/Hwy. 403, in the west end

In February, 1987, Hamilton's Air Pollution Index (API) began reporting from the 29000 - Elgin/Kelly location. Since 1970, the Index had been measured at the 29025 - Barton/Sanford location. Most of Barton's instruments were moved to Elgin, but a few key instruments remained at Barton to maintain trend information from Hamilton's most historic air monitoring station.

The remainder of the network consists of numerous but less sophisticated monitors, many of which have been in existence since 1970. In addition to this regular network, special surveys are carried out to evaluate specific problems. Two special surveys were conducted by the Ministry's Air Resources Branch in 1987, and the results are presented in this report. These surveys were the Phytotoxicology Section's annual survey of vegetation studies done in September 1987, and the Air Quality and Meteorology Section's three week survey with two mobile air monitoring vans in October 1987.

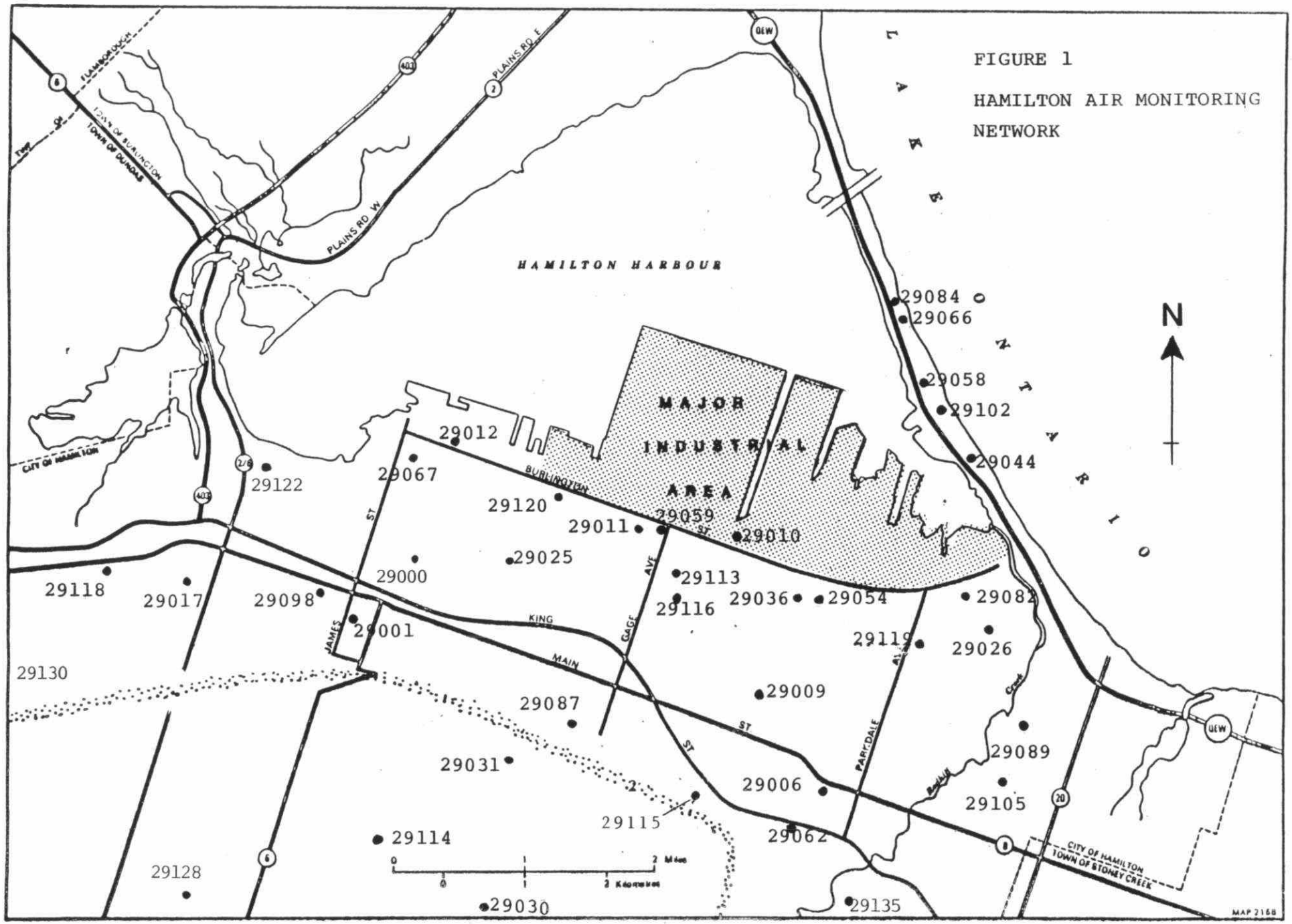


FIGURE 1
HAMILTON AIR MONITORING NETWORK
HAMILTON HARBOUR
LAKE ONTARIO
MAJOR INDUSTRIAL AREA
N
29084
29066
29058
29102
29044
29012
29067
29122
29120
29011
29059
29010
29025
29000
29113
29116
29036
29054
29082
29118
29017
29098
29001
29119
29026
29130
29009
29087
29089
29031
29006
29105
29115
29062
29114
29128
29030
29135
BURLINGTON ST
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
PLAINS RD E
PLAINS RD W
QEW
403
CITY OF HAMILTON
TOWN OF STONEY CREEK
CITY OF BURLINGTON
TOWN OF DUNDAS
TOWN OF FLAMBOROUGH
MAP 2168

TABLE 1

HAMILTON AIR MONITORING STATION LOCATIONS

NUMBER	LOCATION	AIR POLLUTION INDEX	SULPHUR DIOXIDE	OZONE	CARBON MONOXIDE	OXIDES OF NITROGEN	TOTAL REDUCED SULPHUR	SOILING INDEX	SUSPENDED PARTICULATE	FLUORIDE	DUSTFALL	WIND/TEMP
29000	Elgin/Kelly	X	X	X	X	X	X	X				
29001	Hughson/Hunter							X	X	X	X	
29006	Queenston/Craigroyston										X	
29009	Kenilworth/Roxborough								X		X	
29010	Burlington/Ottawa										X	
29011	Burlington/Leeds								X		X	
29012	Burlington/Wellington								X	X	X	
29017	Chatham/Frid								X		X	
29025	Barton/Sanford		X				X	X	X	X	X	
29026	Woodward/Brampton											X
29030	Camden/Mohawk										X	
29031	Concession/Up. Sherman										X	
29036	Roosevelt/Beach Road										X	
29044	Wark/Beach Blvd.										X	

TABLE 1 (cont.)

HAMILTON AIR MONITORING STATION LOCATIONS

NUMBER	LOCATION	AIR POLLUTION INDEX	SULPHUR DIOXIDE	OZONE	CARBON MONOXIDE	OXIDES OF NITROGEN	TOTAL REDUCED SULPHUR	SOILING INDEX	SUSPENDED PARTICULATE	FLUORIDE	DUSTFALL	WIND/TEMP
29054	Beach Road/Conrad									X		
29059	Burlington/Gage									X		
29062	King E./Barons									X		
29066	Killarney/Beach Blvd.									X		
29067	Hughson N./Macaulay								X			
29082	Leaside/Knox										X	
29084	Rembe/Beach Blvd.										X	
29087	Cumberland/Prospect								X			
29089	Barton/Nash								X			
29098	Bay/Main West								X			
29102	Beach Blvd./Towers		X		X	X	X	X	X		X	
29105	Nash/Kentley		X	X				X				

TABLE 1 (cont.)

HAMILTON AIR MONITORING STATION LOCATIONS

NUMBER	LOCATION	AIR POLLUTION INDEX	SULPHUR DIOXIDE	OZONE	CARBON MONOXIDE	OXIDES OF NITROGEN	TOTAL REDUCED SULPHUR	SOILING INDEX	SUSPENDED PARTICULATE	FLUORIDE	DUSTFALL	WIND/TEMP
29113	Gertrude/Depew								X			
29114	Vickers/East 18th		X	X			X	X	X			
29115	London/Justine									X		
29116	Dalkeith/Ottawa									X		
29118	Main W./Highway 403		X	X		X		X	X			
29119	Morley/Parkdale								X	X		
29120	Dickson/Burlington									X		
29122	Dundurn/York								X			
29128	Lynnbrook/Rolston								X			
29130	Ewen/Whitney								X			
29135	Mt. Albion/Albright								X			

Meteorological data (wind speed, wind direction and air temperature) are observed at station 29026, (Woodward Avenue) located on the sewage treatment plant grounds. Figure 2 presents the wind frequency distribution measured and clearly indicates that winds from the southwest predominate.

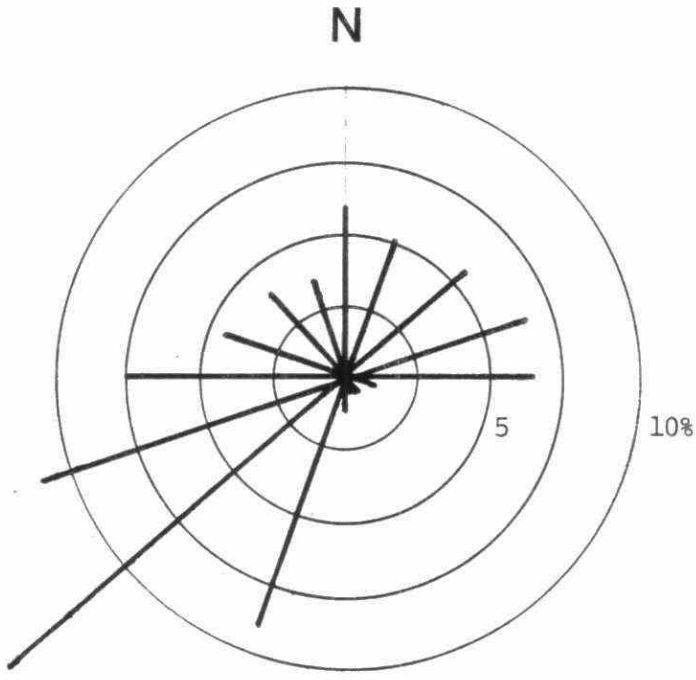
The results of a computer program known as a "pollution rose" are included in this report. The program is essentially a cross-tabulation of hourly pollutant concentrations with wind direction. The data from this program are illustrated on various diagrams. On each "rose", the length of each line drawn is proportional to the average concentration of a pollutant when the wind was blowing <u>from</u> that direction. The longest lines in the diagram usually point to a source or sources of the pollutant in question. The concentrations will be influenced both by the quantity of emissions and by meteorological conditions such as wind speed, etc. As a result, the program is a useful tool in identifying sources of pollutants.

FIGURE 2

WIND FREQUENCY DISTRIBUTION

HAMILTON - 1987

29026 - Woodward Ave. Sewage Treatment Plant



Lines indicate direction wind blew from

4. ANALYSIS OF DATA

4.1 Air Pollution Index

The Hamilton air pollution index (API) is used as a warning system to alert the public to elevated air pollution levels and as a trigger for cutbacks in industrial emissions. It is derived from 24 hour average concentrations of sulphur dioxide and particulate matter measured at the Elgin/Kelly station beginning in February, 1987. Prior to this, the index was measured at the Barton/Sanford station. The combination of these two pollutants at elevated levels is indicative of detrimental human health effects. Hourly concentrations of both pollutants are telemetered to a central computer facility in Toronto which then calculates the index hourly, based on the following equation:

$$API = 2.5(13.9\ COH + 104.5\ SO_2).^8$$

Where: COH is the 24-hour average soiling index concentration expressed in coefficient of haze units.

SO_2 is the 24-hour average sulphur dioxide concentration expressed in parts per million.

No action is taken for readings up to 31. At 32, known as the advisory level, and with a forecast of unfavorable dispersion conditions, major industries are notified and asked to voluntarily curtail certain operations. At an API of 50, cutbacks by these sources become mandatory. These levels are set with a considerable safety margin before health effects to sensitive people would be expected. At 75, further cutbacks would be ordered, and at 100 all sources not essential to public health and safety could be ordered to cease operations.

TABLE 2

AIR POLLUTION INDEX - 1987

OCCASSIONS WHEN 32 OR ABOVE

Date	No. of Hours ≥ 32	Maximum
1987		
1. April 21	3	32
2. Oct. 16-17	17	35

NUMBER OF INCIDENTS AND HOURS ABOVE 31

	Number	Hours	Maximum
1987	2	20	35
1986	5	48	37
1985	2	28	36
1984	9	153	44
1983	1	26	37
1982	13	203	39
1981	8	118	38
1980	5	71	40
1979	22	485	55
1978	7	93	43
1977	9	201	44

During 1987, there were two incidents in which the API reached or exceeded 32, one in the spring and one in the fall, as given in Table 2.

Both incidents were a result of the classical lake breeze phenomenon, in which a warm southerly air mass was undercut by a cool northeast breeze off a cold Lake Ontario resulting in a temperature inversion.

A high variability in the numbers of incidents each year is shown in Table 2. This variability from year to year is weather related, that is, the frequency of typical inversion conditions. However, there does appear to be a general decline in the frequency of these incidents.

For many years, the API station was located close to a major street - Barton Street, and at ground level. A prime cause of elevated API values was the soiling index (co-efficient of haze) term in the API equation. Peaks at rush hour, particularly during inversions, were prominent in the data, as were reduced levels during night hours when traffic was reduced.

For this reason, the Elgin/Kelly station was established in 1987, to be more remote from individual traffic influences and thus to give a more accurate representation of general downtown air quality in Hamilton. Most of the other index stations in the Province are located in similar downtown areas.

4.2 Particulates

There are three basic types of instruments employed for the measurement of particles, each type relating to a different size range:

(a) Dustfall jars measuring heavy material, generally greater than 10 microns in diameter (one micron is one-millionth of a metre).
(b) High volume samplers measuring suspended particulates ranging in size from submicron to 50 microns
(c) Co-efficient of haze tape samplers measuring mostly fine material - from submicron to about 10 microns.

The ambient air quality objectives for suspended particulate are based on health effects when occurring in combination with sulphur dioxide. As mentioned previously, this combination was proven to be indicative but not necessarily causative of such health effects. The dustfall objectives are based on nuisance effects while the soiling index objectives were derived from correlations with suspended particulate data.

4.2.1 Total Suspended Particulates

A high volume sampler draws a known volume of air through a pre-weighed filter for a 24 hour period (midnight to midnight). The exposed filter is weighed and the difference (weight of particulate matter on filter) in conjunction with the known air flow is expressed as a concentration in micrograms per cubic meter. The objective for a 24-hour average is 120 ug/m^3 while the yearly geometric mean objective is 60 ug/m^3.

At two locations in Hamilton, the Barton/Sanford and Beach Blvd. stations, these samplers operated daily. At seventeen other locations, they ran on a once every sixth day cycle, consistent with the practice in other North American jurisdictions.

Suspended particulate data is summarized in Table 3a and shows a definite gradient of higher concentrations closer to the

TABLE 3a

SUSPENDED PARTICULATES - 1987
UNIT - MICROGRAMS PER CUBIC METER
unless otherwise specified

ONTARIO OBJECTIVES: 24 hour - 120
1-year Geo. Mean - 60

LOCATION	Geometric Mean 1985	1986	1987	Maximum 1987	%of Samples Above 120 1987
29001 - Hughson/Hunter	55	70	63	270	11
29009 - Kenilworth/Roxborough	56	61	60	193	7
29011 - Burlington/Leeds	113	110	99	330	39
29012 - Burlington/Wellington	83	66	59	215	7
29017 - Chatham/Frid	61	79	80	325	14
29025 - Barton/Sanford	71	75	76	362	20
29067 - 450 Hughson St. N.	52	51	46	113	0
29087 - Cumberland/Prospect	56	52	51	220	9
29089 - Barton/Nash	55	62	54	189	2
29098 - Bay/Main	42	52	51	174	9
29102 - Beach Blvd.	69	73	70	322	18

TABLE 3a - Continued

SUSPENDED PARTICULATES - 1987
UNIT - MICROGRAMS PER CUBIC METER
unless otherwise specified

ONTARIO OBJECTIVES: 24 hour - 120
1-year Geo. Mean - 60

LOCATION	Geometric Mean 1985	1986	1987	Maximum 1987	%of Samples Above 120 1987
29113 - Gertrude/Depew	-	87^{9}	84^{9}	265	21
29114 - Vickers/East 18th	41	45*	53	178	9
29118 - Main W./Highway 403	47	47+	52	223	7
29119 - Morley/Parkdale	-	96^{11}	104	489	36
29122 - Dundurn Castle	41	-	43	225	2
29128 - Lynnbrook/Rolston	39	-	53^{7}	105	0
29130 - Ewen/Whitney	38	-	40	108	0
29135 - Mt. Albion/Albright	38	-	43	154	2

9 - Numerical exponent refers to number of months sampled when less than 12.
* - Station moved to 29114 from 29085 in mid-1985
+ - Station moved to 29118 from 29090 at end of 1985

industrial area. Concentrations in 1987 were fairly similar to 1986 levels.

Four new stations were established in 1987. Actually, these locations had in the past, been maintained by McMaster University as part of a larger network for their health study of children. This project has now ended, so the Ministry has restarted four locations in order to provide broad coverage of the city.

Two stations indicated local problems, probably due to fugitive dust generated by heavy truck traffic and/or dust blowoff from unpaved areas. The first is the 29017 - Chatham/Frid station. This has been a long-standing problem and the area could be improved by paving and landscaping. The other problem area is a relatively new station at 29119 - Morley/Parkdale. This station, while located well away from busy Parkdale Avenue, was still affected by heavy truck traffic which passed nearby.

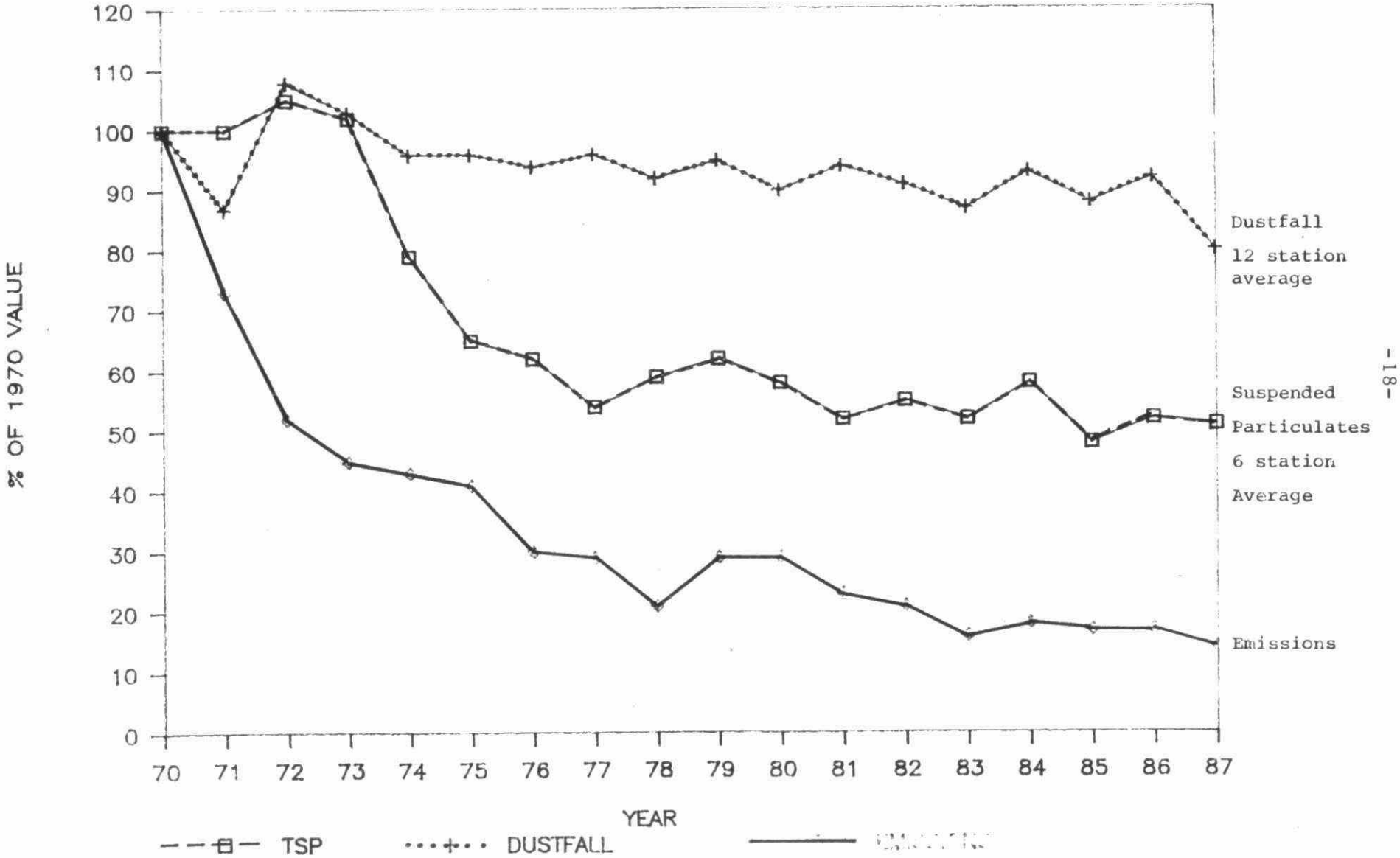
The overall trend in TSP since 1970 is shown in Figure 3, which displays a leveling off in concentrations since 1977, although a slight downward trend over these years is still evident. The trend curve for industrial emissions also shows a slight downward slope over this period. While the trends of TSP and emissions are similar, the magnitude of change is not, the emissions have decreased more than the TSP. This is probably because other pollution sources, which have not been lessened, had and continue to have an effect on the TSP, e.g. unquantified sources such as road dust, wind blown dust from unpaved areas etc.

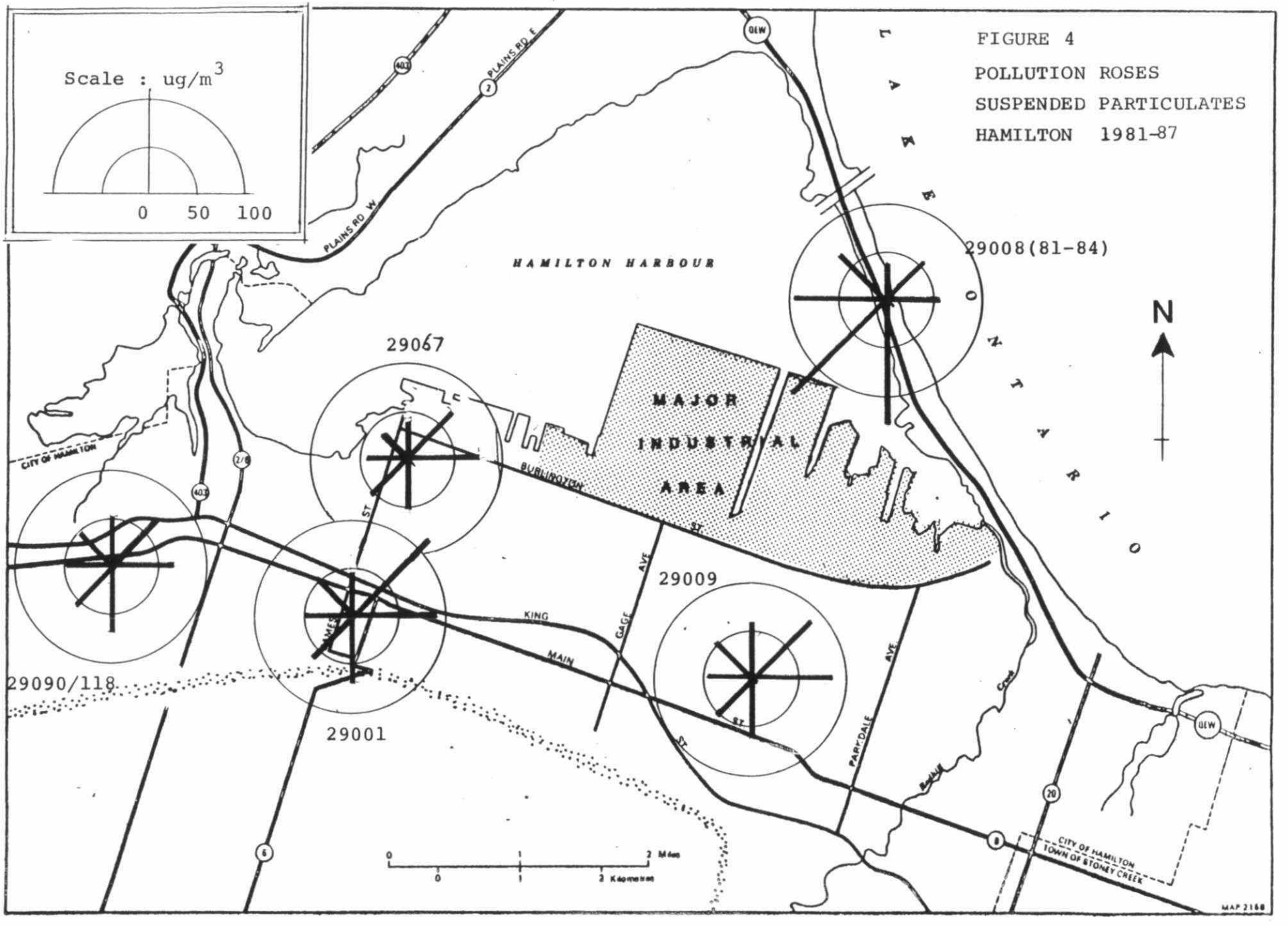
Pollution roses (Figures 4-6) for 1981-87 suspended particulates were manually calculated for all stations by grouping the data according to predominant daily wind

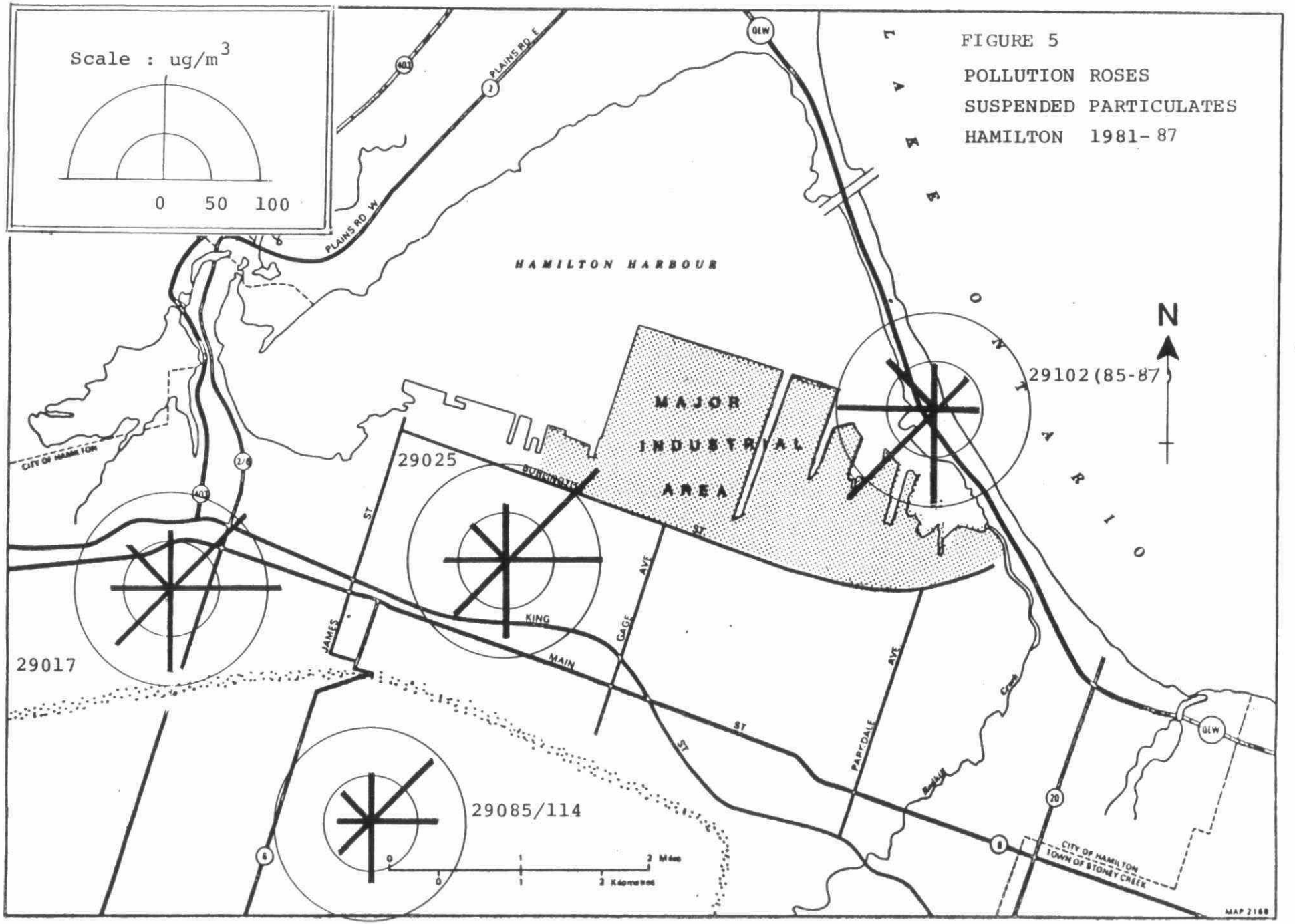
FIGURE 3

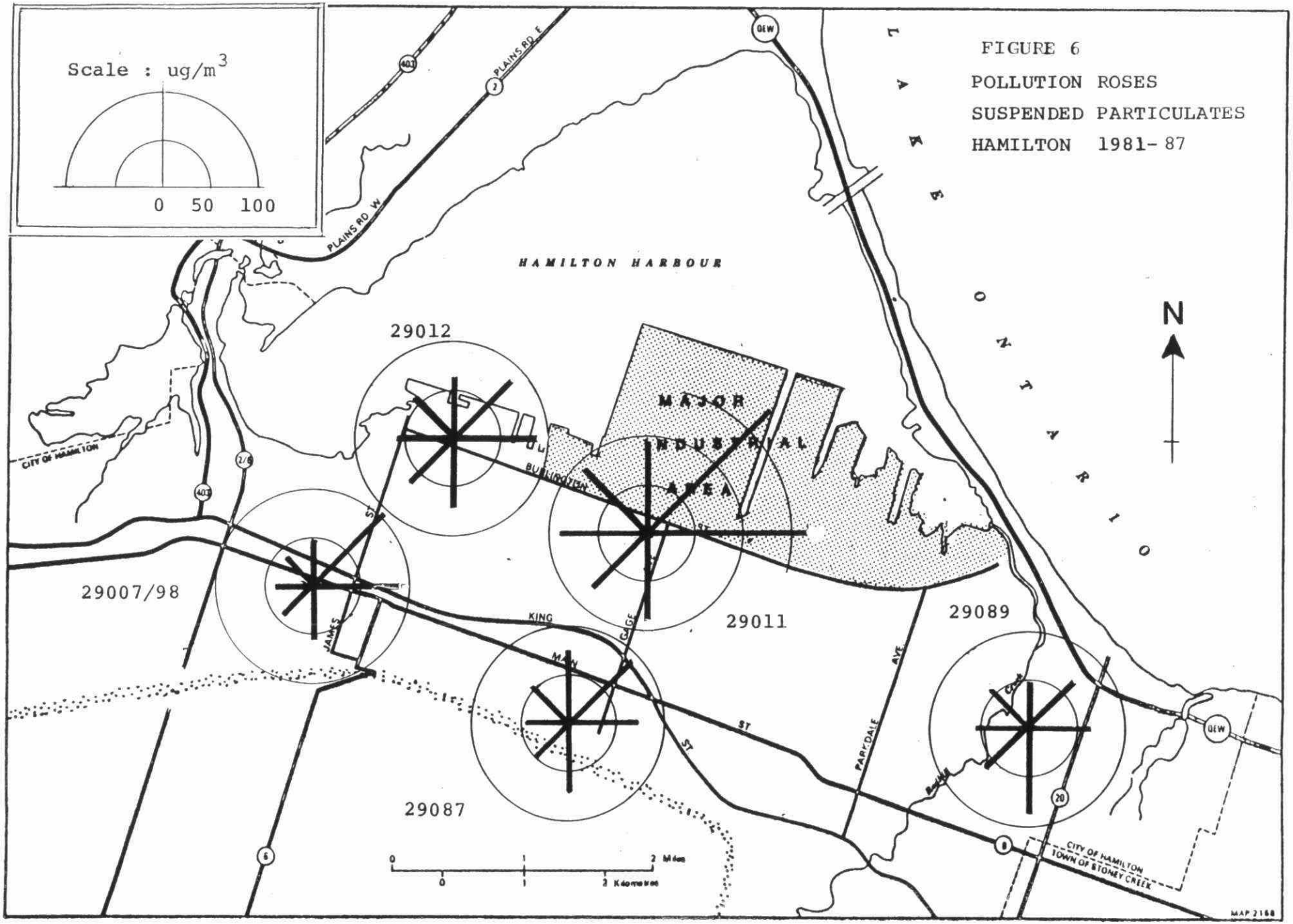
PARTICULATE/EMISSIONS TRENDS

HAMILTON 1970 – 1987




Scale : ug/m3
0 50 100
FIGURE 4
POLLUTION ROSES
SUSPENDED PARTICULATES
HAMILTON 1981-87
29008(81-84)
29067
29009
29090/118
29001
HAMILTON HARBOUR
MAJOR INDUSTRIAL AREA
ONTARIO
N
PLAINS RD E
PLAINS RD W
BURLINGTON ST
KING ST
MAIN ST
GAGE AVE
PARKDALE AVE
CITY OF HAMILTON
CITY OF HAMILTON
TOWN OF STONEY CREEK
QEW
403
MAP 2168


Scale : ug/m3
0 50 100
FIGURE 5
POLLUTION ROSES
SUSPENDED PARTICULATES
HAMILTON 1981-87
HAMILTON HARBOUR
LAKE ONTARIO
MAJOR INDUSTRIAL AREA
29102 (85-87)
29025
29017
29085/114
N
PLAINS RD E
PLAINS RD W
CITY OF HAMILTON
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
CITY OF HAMILTON
TOWN OF STONEY CREEK


Scale : ug/m3
0 50 100
FIGURE 6
POLLUTION ROSES
SUSPENDED PARTICULATES
HAMILTON 1981-87
HAMILTON HARBOUR
LAKE ONTARIO
N
29012
MAJOR INDUSTRIAL AREA
29007/98
29011
29089
29087
CITY OF HAMILTON
PLAINS RD E
PLAINS RD W
BURLINGTON ST
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
QEW
403
CITY OF HAMILTON
TOWN OF STONEY CREEK
0 1 2 Miles
0 1 2 Kilometres
MAP 2168

directions (as opposed to the hourly pollution rose computer program which classes hourly data). Only those days for which a clear predominant direction could be determined were included and rainfall/snowfall days were excluded. Since most of the stations operate once every sixth day, roses for a single year cannot be drawn due to an insufficient number of samples per year. A multi-year approach was therefore made. Most of the 14 roses indicate a strong correlationship of higher averages with winds from the industrial sector. Several of the roses indicate local non-industrial influences as well, such as road traffic.

The hi-vol filters were analyzed for seven metals, as well as sulphates and nitrates (Table 3b).

Concentrations of nickel, cadmium, lead and vanadium showed very low concentrations which did not vary appreciably throughout the city indicating that they were background levels. The 24-hour criteria for these metals were easily met. The 1987 nickel averages showed an increase, but this is due to changes in data handling procedures rather than real change. Most of the samples recorded levels below the analytical detection limit. A change in how the computer handles these values affected the 1987 averages.

Concentrations of chromium and manganese showed a gradient with distance from the industrial area. However, even the highest levels were well below acceptable levels. A change in chromium averages is due to the same reasons as mentioned above for nickel.

Iron concentrations were high, and also showed a gradient with distance from the industrial area where concentrations were often well above general background levels, but usually below guideline values which are based on soiling effects.

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	Criterion:2.0(24 hours) CADMIUM # of Samples	Geo. Mean	Max.	Criterion:1.5(24 hours) CHROMIUM # of Samples	Geo. Mean	Max.	Criterion:25.0(24 hours, Ferric Oxide) IRON # of Samples	Geo. Mean	Max.	Criterion:5.0(24 hours) LEAD # of Samples	Geo. Mean	Max.	Criterion:2.5(24 hours) MANGANESE # of Samples	Geo. Mean	Max.
29001 Hughson/Hunter															
1984	57	.002	.006	57	.001	.060	57	1.9	11.4	57	0.4	1.1	57	.10	.83
1985	57	.001	.004	57	.001	.073	57	1.5	11.1	57	0.2	0.5	57	.09	.57
1986	59	.001	.017	59	.001	.084	59	1.7	38.0	59	0.2	1.1	59	.10	2.39
1987	55	.001	.012	55	.009	.040	55	1.5	13.1	55	0.1	0.4	55	.09	.68
29008/29102 Beach Blvd.															
1984	51	.001	.005	51	.007	.056	51	3.1	13.9	51	0.4	1.2	51	.21	.92
1985*	52	.001	.004	52	.002	.037	52	2.5	12.2	52	0.1	0.5	52	.18	.81
1986	57	.001	.006	57	.002	.033	57	3.0	10.0	57	0.2	0.6	57	.17	.87
1987	51	.001	.007	51	.012	.060	51	3.0	20.3	51	0.1	0.6	51	.19	1.40
29011 Burlington/Leeds															
1984	59	.002	.015	59	.013	.219	59	5.1	18.3	59	0.4	0.9	59	.34	1.48
1985	58	.002	.005	58	.020	.092	58	5.4	23.2	58	0.3	0.7	58	.40	2.16
1986	59	.001	.004	60	.018	.067	60	4.9	24.9	60	0.2	0.7	60	.41	1.32
1987	57	.001	.007	57	.026	.120	57	5.1	32.5	57	0.2	0.4	57	.32	1.84
29012 Burlington/ Wellington															
1984	57	.001	.010	57	.002	.038	57	1.9	10.2	57	0.3	0.8	57	.11	.43
1985	58	.001	.022	58	.002	.052	58	2.1	6.0	58	0.2	0.5	58	.16	1.29
1986	59	.000	.003	59	.001	.023	59	1.2	10.8	59	0.1	0.5	59	.12	.91
1987	57	.001	.009	57	.010	.030	57	1.4	10.5	57	0.1	0.3	57	.11	.81

*29008 moved to 29102 in 1985.

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

	Criterion: 2.0(24 Hours)			Criterion: 2.0 (24 Hours)								
	NICKEL			VANADIUM			NITRATE			SULPHATE		
Station and Year	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29001 Hughson/Hunter												
1984	57	.005	.049	57	.00	.04	57	4.2	16.6	57	10.7	35.8
1985	57	.002	.015	57	.00	.04	57	3.1	10.0	57	6.9	16.2
1986	59	.001	.028	59	.00	.04	59	4.4	37.2	59	10.6	29.7
1987	55	.004	.020	55	.01	.06	56	4.2	16.1	56	10.5	20.8
29008/29102 Beach Blvd.												
1984	51	.004	.043	51	.00	.04	50	4.2	27.2	50	11.6	35.1
1985*	52	.003	.022	52	.00	.03	37	2.8	16.6	37	8.4	19.4
1986	57	.000	.025	57	.00	.04	57	3.5	18.8	57	10.9	39.7
1987	51	.006	.040	51	.01	.04	51	3.0	19.7	51	12.9	21.9
29011 Burlington/Leeds												
1984	59	.006	.024	59	.01	.04	58	3.6	19.6	58	11.7	33.8
1985	58	.004	.026	58	.00	.05	58	4.1	19.3	58	10.7	26.0
1986	60	.001	.024	60	.01	.04	60	4.1	36.4	60	12.3	43.4
1987	57	.006	.030	57	.01	.10	57	2.7	13.7	57	11.7	23.8
29012 Burlington/ Wellington												
1984	57	.003	.149	57	.00	.05	57	4.1	18.0	57	9.6	36.4
1985	58	.002	.059	58	.00	.03	57	4.3	14.9	57	9.2	21.7
1986	59	.000	.017	59	.00	.06	59	4.0	34.9	59	9.4	40.0
1987	57	1004	.020	57	.01	.07	57	3.1	12.0	57	8.7	19.3

*29008 moved to 29102 in 1985.

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	Criterion:2.0(24 hours) CADMIUM # of Samples	Geo. Mean	Max.	Criterion:1.5(24 hours) CHROMIUM # of Samples	Geo. Mean	Max.	Criterion:25.0(24 hours)-Ferric Oxide IRON # of Samples	Geo. Mean	Max.	Criterion:5.0(24 hours) LEAD # of Samples	Geo. Mean	Max.	Criterion:2.5(24 hours) MANGANESE # of Samples	Geo. Mean	Max.
29017 Chatham/Frid															
1984	57	.001	.003	57	.003	.033	57	2.2	9.1	57	0.3	1.9	57	.11	.77
1985	57	.001	.003	57	.001	.036	57	1.7	6.2	57	0.2	0.4	57	.09	.49
1986	57	.000	.002	57	.004	.035	57	2.4	12.8	57	0.2	0.7	57	.11	.47
1987	58	.000	.006	58	.009	.110	58	2.3	30.6	58	0.1	0.3	58	.12	.63
29025 Barton/Sanford															
1984	57	.002	.011	57	.004	.073	57	3.1	22.5	57	0.4	2.2	57	.18	1.42
1985	51	.001	.006	51	.004	.309	51	1.5	14.9	51	0.3	1.1	51	.19	1.74
1986	55	.001	.004	55	.002	.086	55	2.8	26.8	55	0.3	1.0	55	.15	1.19
1987	53	.001	.013	53	.013	.200	53	2.5	29.6	53	0.2	1.2	53	.17	5.29
29067 Hughson/Macavley															
1984	56	.001	.005	56	.002	.027	56	1.3	9.9	56	0.2	0.6	56	.07	.59
1985	58	.001	.009	58	.001	.026	58	1.4	5.4	58	0.1	0.4	58	.09	.43
1986	58	.000	.003	58	.003	.028	58	1.0	11.6	58	0.1	0.5	58	.07	.50
1987	50	.001	.007	50	.012	.030	50	0.9	7.8	50	0.1	0.2	50	.06	.66
29085/29114 Vickers/East 18															
1984	58	.001	.007	58	.001	.034	58	1.1	9.5	58	0.2	0.8	58	.06	.68
1985	57	.001	.003	57	.001	.084	57	0.8	9.7	57	0.1	0.5	57	.06	.39
1986*	54	.001	.005	54	.001	.026	54	0.7	8.7	54	0.1	0.6	54	.05	.44
1987	55	.001	.007	55	.012	.060	55	1.1	22.1	55	0.1	0.5	55	.07	.90

*29085 moved to 29114 at end of 1985

TABLE 3b CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	Criterion: 2.0(24 Hours) NICKEL # of Samples	Geo. Mean	Max.	Criterion: 2.0 (24 Hours) VANADIUM # of Samples	Geo. Mean	Max.	NITRATE # of Samples	Geo. Mean	Max.	SULPHATE # of Samples	Geo. Mean	Max.
29017 Chatham/Frid												
1984	57	.007	.066	57	.00	.03	58	4.0	18.1	58	11.0	24.7
1985	57	.004	.021	57	.00	.03	58	3.2	11.2	58	6.6	17.6
1986	57	.001	.022	57	.00	.14	57	3.5	11.5	57	9.2	44.0
1987	58	.005	.070	58	.01	.07	51	3.5	12.9	58	9.8	21.2
29005 Barton/Sanford												
1984	57	.005	.031	57	.00	.03	57	3.4	16.4	57	10.4	35.1
1985	51	.006	.040	51	.00	.04	52	3.3	14.7	52	8.4	18.9
1986	55	.001	.042	55	.00	.05	55	3.8	33.5	55	11.2	25.1
1987	53	.006	.060	53	.01	.14	54	3.9	17.6	54	13.0	40.9
29067 Hughson/Macavley												
1984	55	.005	.031	56	.00	.02						
1985	58	.004	.039	58	.00	.03						
1986	58	.002	.020	58	.00	.02						
1987	50	.004	.010	50	.01	.03						
29085/29114 Vickers/East 18th												
1984	58	.001	.030	58	.00	.03	58	3.2	14.3	58	8.4	28.5
1985	57	.001	.018	57	.00	.03	57	2.6	8.7	57	6.0	19.3
1986*	54	.003	.047	54	.00	.02	54	2.6	15.2	54	7.9	37.4
1987	55	.006	.120	55	.01	.09	56	4.6	12.5	56	11.6	24.4
29087 Cumberland/ Prospect												
1984							55	3.0	15.8	55	8.8	26.8
1985							56	3.0	11.3	56	7.3	20.4
1986							58	3.3	42.4	58	9.2	38.9
1987							57	3.2	14.5	57	10.1	18.6

*29085 moved to 29114 at end of 1985

The sulphate/nitrate components comprised a large portion of the measured particulate matter. These constituents are largely by-products of major high temperature fuel combustion sources and can travel hundreds of miles from their source. The concentrations in Hamilton are normally higher in the industrial area, indicating a contribution from local industries. However, in 1987, mountain station 29114 recorded a yearly mean equal to that of industrial zone station 29011.

Most of the City shows levels only moderately higher than other areas in the province including rural areas, indicating that much of this material is imported into the city via long range transport from distant sources. The sulphate/nitrate components are known to be a factor in reduced visibility[2] and are often likely responsible for the widespread haze observed in Hamilton during southerly winds.

The sulphate concentrations showed large increases at most stations in 1986 returning to pre-1985 levels (Levels in 1985 were unusually low). In 1987, averages remained at this 1986 level and in some cases increased even further. The nitrate portion was unchanged in most cases. The increase in sulphate levels which are largely imported into the city, may indicate that a greater amount of "background" particulate entered the city from distant sources. Sulphate levels increased throughout Southern Ontario in 1986 and 1987.

It should be noted that the sulphate/nitrate analyses are subject to some error due to the measurement methodology. For this reason the data should be primarily used for evaluation of trends rather than use of the actual values. Alternative methodologies and filters are under investigation to improve the measurement technique. Tests with a new filter medium indicate that the glass fibre filter can cause as much as 8 ug/m^3 on average of spurious sulphate/nitrate formation from

gaseous sulphur dioxide and nitrogen oxides. It is possible that the higher industrial area sulphate levels are related to this error, since gaseous sulphur dioxide and nitrogen oxide levels are somewhat higher there.

Hi-vol filters from four stations were analyzed for total carbon, elemental carbon and carbonate. Elemental carbon would include material such as coal, coke and kish, while total carbon would include numerous forms, both organic and inorganic in nature. Carbonate would include calcium carbonate (limestone) and dolomite. Sources of these carbonaceous materials would include coke ovens, blast furnaces, stockpiles, vehicle exhaust, biological materials and crushed stone.

Data are given in Table 3c and show a distinct gradient in concentration with distance from the industrial area. Levels were highest at 29011 (Burlington/Leeds) in the middle of the industries, followed by 29025 (Barton/Sanford) and 29102 (Beach Blvd.) on the fringes of the area followed by much lower levels at 29114 (Vickers/E18th) on the mountain. These higher particulate levels are a result of both direct emissions and contributions from traffic, particularly heavy truck traffic.

A contour map of suspended particulate concentrations is given in Figure 7. It can be seen that the majority of the city met the yearly objective of 60 ug/m^3. Concentrations were only elevated close to the industrial area. Once again it should be stressed that airborne particulate is not solely due to direct emissions from industrial sources. Dirty roadways and heavy truck traffic can also be contributors.

It should be realized that these contour maps of concentrations are not strictly a definitive representation of

TABLE 3c

CARBON CONTENTS IN SUSPENDED PARTICULATES (ug/m³) - 1985-87

Station	Year	No. of Samples	TOTAL CARBON Geo. Mean	TOTAL CARBON Max.	ELEMENTAL CARBON Geo. Mean	ELEMENTAL CARBON Max.	CARBONATE (CO_3) Geo. Mean	CARBONATE (CO_3) Max.
29011								
Burlington/Leeds	1985	58	13.7	35.2	5.0	18.1	1.3	11.3
	1986	54	11.7	45.6	3.9	18.0	1.2	10.5
	1987	57	10.8	40.0	3.6	17.0	0.7	7.5
29025								
Barton/Sanford	1985	51	9.1	20.1	3.4	11.9	0.6	3.7
	1986	50	10.2	29.9	3.5	16.3	0.7	3.5
	1987	53	9.4	34.0	2.9	17.9	0.2	3.9
29085/114								
Mountain Police	1985	55	5.9	18.9	1.8	8.9	0.4	2.5
	1986	52	5.4	23.4	1.0	6.8	0.1	2.7
	1987	56	5.8	20.3	1.2	7.3	0.1	4.4
29102								
Beach Blvd.	1985	52	9.4	27.5	3.4	14.0	0.4	2.2
	1986	49	8.5	20.6	3.5	13.5	0.3	9.4
	1987	51	7.1	24.1	2.6	11.2	0.1	3.3

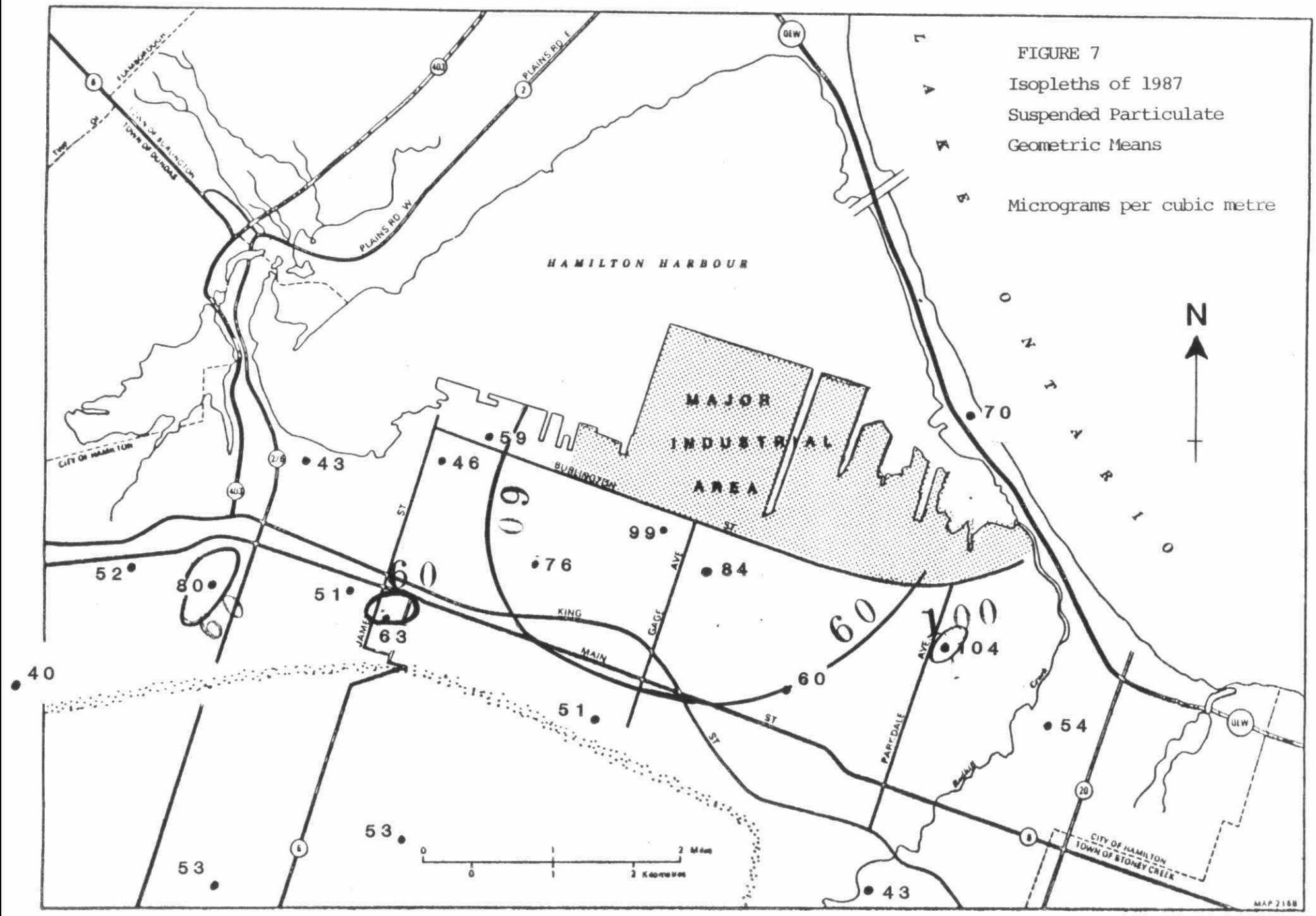


FIGURE 7
Isopleths of 1987
Suspended Particulate
Geometric Means
Micrograms per cubic metre
HAMILTON HARBOUR
MAJOR INDUSTRIAL AREA
ONTARIO
N
43
46
59
70
52
80
51
76
99
84
63
104
40
51
54
53
53
43
60
100
CITY OF HAMILTON
TOWN OF STONEY CREEK
PLAINS RD W
PLAINS RD E
BURLINGTON ST
KING ST
MAIN ST
GAGE AVE
PARKDALE AVE
0 1 2 Miles
0 1 2 Kilometres

city wide air quality. Local influences affect some of the stations, and several more stations were required to fill in some gaps. Three small contours drawn in Figure 7 have no scientific validity. They are only drawn to indicate that particular stations were subject to local sources such as traffic, unrepresentative of overall patterns.

Since Figure 7 reflects long term average conditions, it indicates a rather limited industrial contribution to suspended particulate levels throughout the city. A different situation exists during inversions accompanied by light northeast winds. Under inversion conditions, with poor dispersion, pollution from all sources including traffic can accumulate and will contribute to the totals.

Figures 8 and 9 depict suspended particulate contour maps during two elevated API incidents during the year on February 26 and April 21. Each map readily displays increased concentrations measured city-wide, diminishing with distance from the industrial complex. The contours are also skewed toward the southwest reflecting the wind flow from the northeast. The industrial contribution is obvious on these occasions whether it be direct emissions, fugitive emissions or roadway sources inside or outside plants in the industrial area.

One other notable map for May 9, 1987 is given in Figure 10. This was a day of very strong southwest winds gusting up to 76 km/hr. TSP concentrations were high throughout Southern Ontario and were due to fugitive wind blown dust sources. As can be seen, a contour cannot be drawn through the map as levels were basically uniform throughout the city, except for the presence of local sources near some stations. The Beach location measured the highest reading indicating that fugitive emissions need to be reduced in the industrial area. The

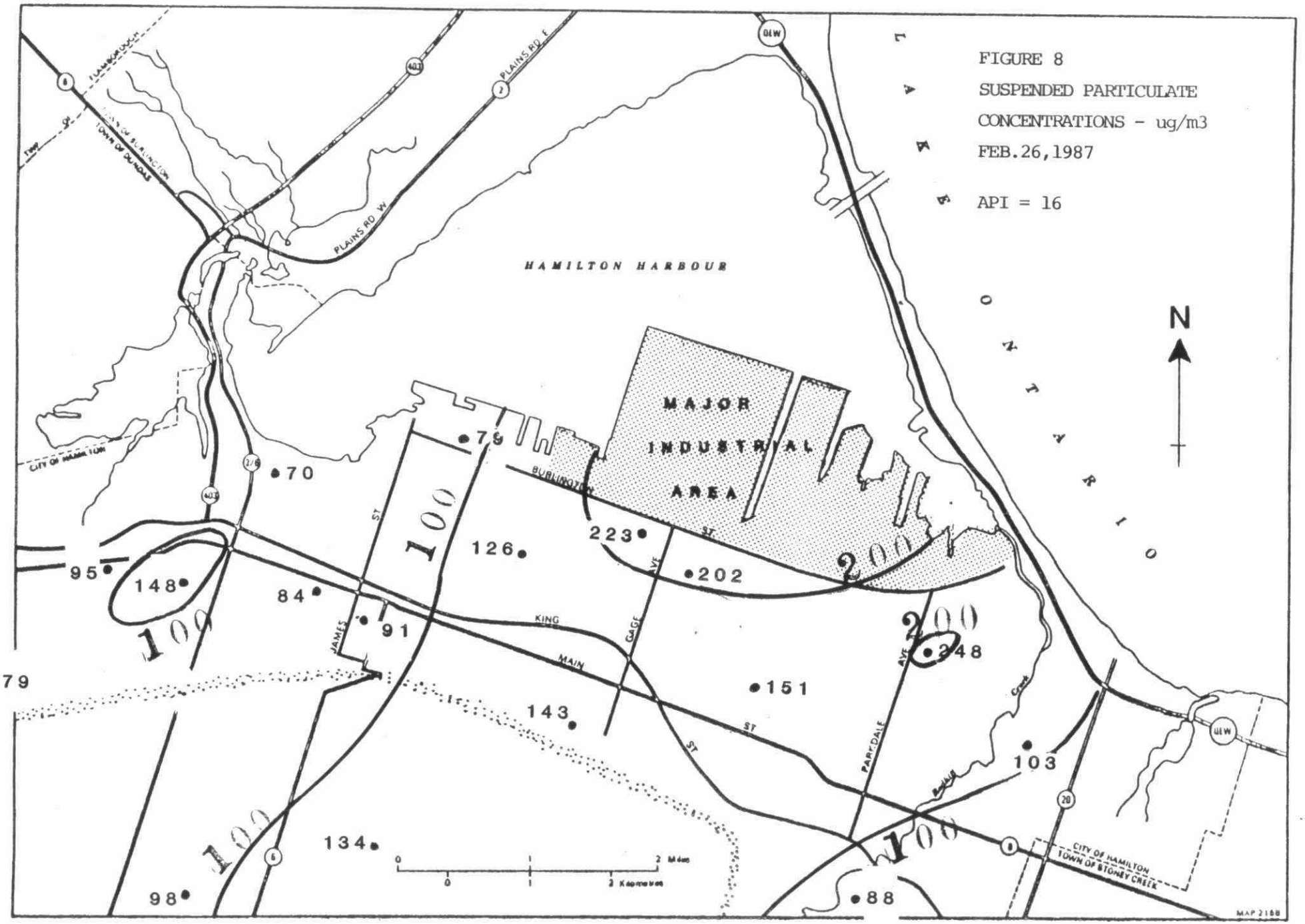


FIGURE 8
SUSPENDED PARTICULATE
CONCENTRATIONS - ug/m3
FEB.26,1987

API = 16

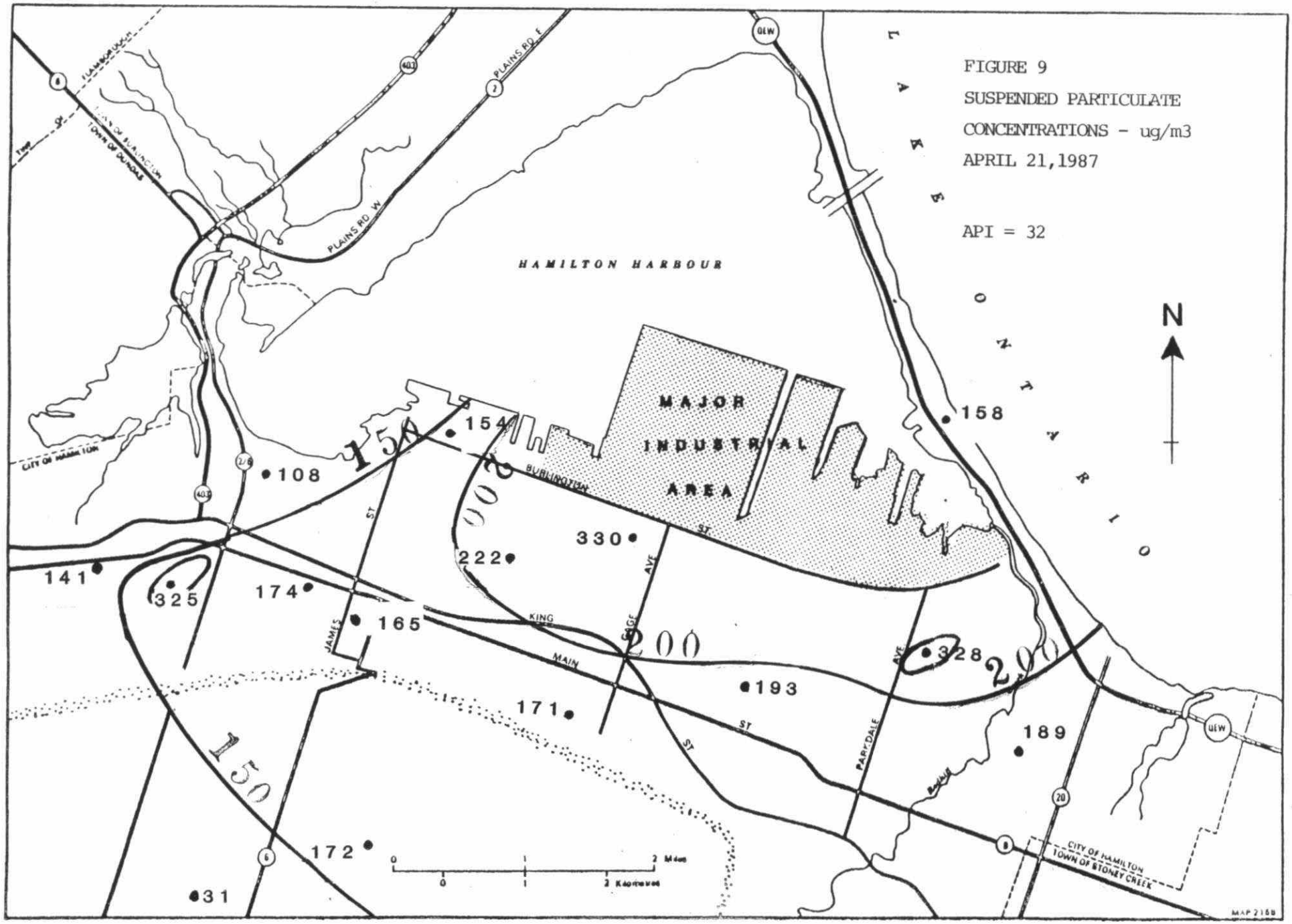


FIGURE 9
SUSPENDED PARTICULATE
CONCENTRATIONS - ug/m3
APRIL 21,1987
API = 32
HAMILTON HARBOUR
LAKE ONTARIO
MAJOR INDUSTRIAL AREA
N
158
154
108
330
222
141
325
174
165
328
193
171
189
172
31
150
200
CITY OF HAMILTON
TOWN OF STONEY CREEK
CITY OF HAMILTON
TOWN OF DUNDAS
PLAINS RD. E
PLAINS RD. W
BURLINGTON ST
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
QEW
0 1 2 Miles
0 1 2 Kilometres

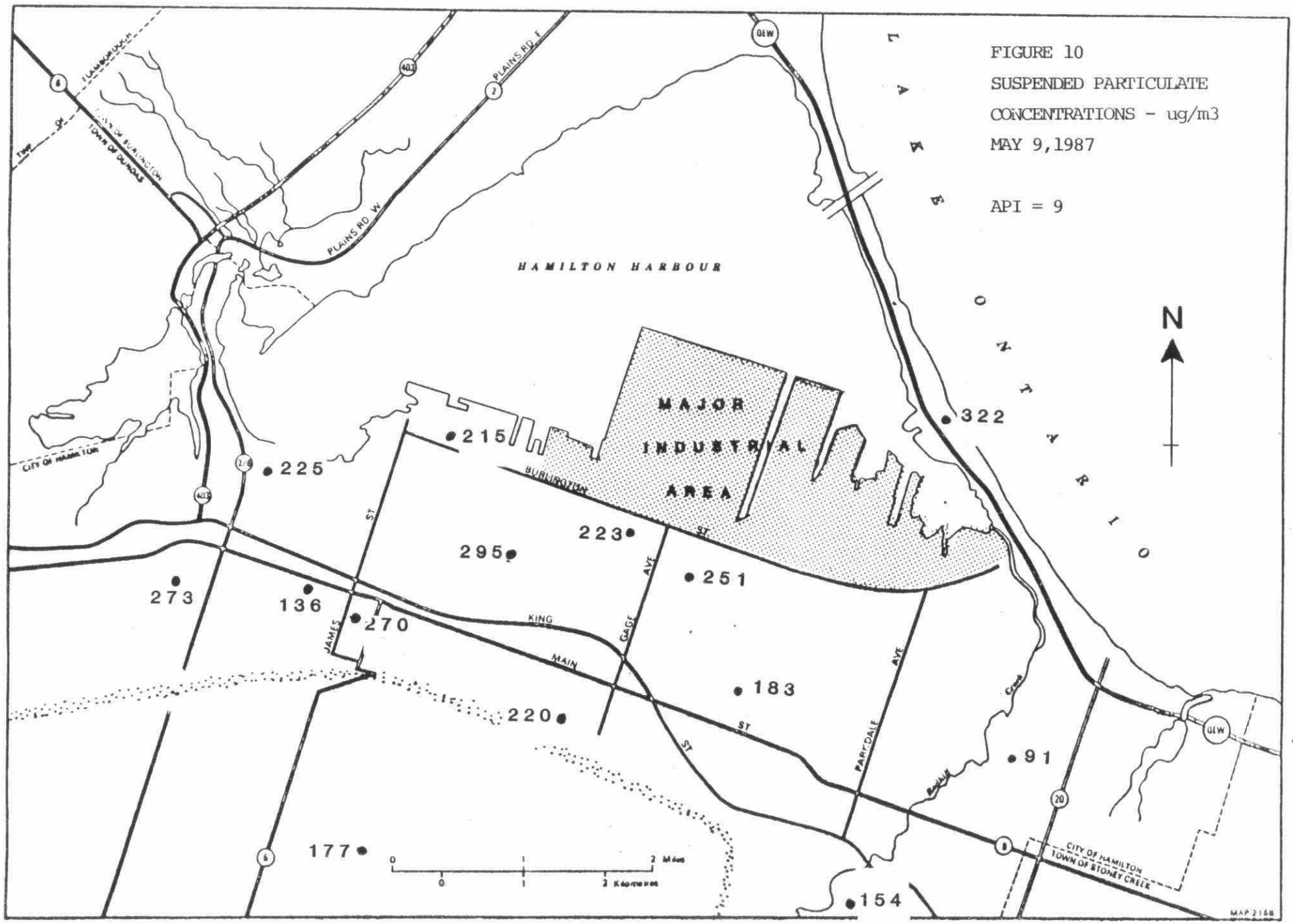


FIGURE 10
SUSPENDED PARTICULATE
CONCENTRATIONS - ug/m3
MAY 9,1987
API = 9
HAMILTON HARBOUR
LAKE ONTARIO
MAJOR INDUSTRIAL AREA
N
322
215
225
223
295
251
273
136
270
183
220
91
177
154
BURLINGTON ST
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
PLAINS RD W
PLAINS RD E
CITY OF HAMILTON
TOWN OF STONEY CREEK
0 1 2 Miles
0 1 2 Kilometres

Chatham/Frid and Hughson/Hunter stations were the next highest.

In conclusion, the suspended particulate data indicate that the industrial area has an impact on the City,but that the effect is usually limited to a relatively small area near the mill sites. During inversion conditions, broader impacts are noted.

Most major sources in industry have now been controlled and the remaining sources are being abated in compliance with Control Orders. These Orders include controls on cast houses for blast furnace D at Stelco. Dofasco has completed a control program at the No. 1 melt shop. Stelco will be required to upgrade controls on the sinter plant. The need for additional controls on the SWARU incinerator is being reviewed. A Control Order is being served on Slater Steel to control particulate emissions and investigations are being made into upgrading controls on the Canron Pipe Division. Inside company properties, programs are in operation to control roadway sources of particulate. Roads have been paved and road cleaning is performed regularly. Better control of trackout to public streets still appears necessary, as well as improved cleaning of public streets. Landscaping of industrial properties has also been ongoing for some time in order to reduce wind-blown dust.

4.2.2 Soiling Index (Co-efficient of Haze)

Co-efficient of haze tape samplers operate continuously and determine hourly soiling values. Air is drawn through a filter paper, and the optical density of the soiled spot is measured by light transmittance. The instrument takes readings prior to and after sample collection. The resultant light obstruction is determined and transmitted on a real time

basis to the data bank for the two main telemetered stations while manual reading of charts was still required for four other monitors. Data are given in Table 4 for seven stations.

In 1987, concentrations were below the yearly objective at 6 of 7 stations. Only 29025 (Barton/Sanford) was slightly above the objective.

The daily objective was most frequently exceeded at Barton/Sanford - a total of 15 days.

Historical data are available only for the Beach and Barton stations and trend graphs for both are illustrated in Figure 11. Barton has fluctuated near the annual objective since 1972 while Beach dropped dramatically in 1985 to the present time. This drop coincided with the move of the Beach station from its old North Park location immediately adjacent to the Queen Elizabeth Way. This old location was obviously heavily impacted on by highway traffic. In 1984, the daily COH objective was exceeded 79 times at North Park, compared to only one time at the new Beach Blvd. location in 1986 and none at all in 1987. This tends to indicate that the soiling index measurement predominantly measures vehicle traffic particulate when located close to a traffic artery. This would account for the fact that Barton/Sanford COH levels have decreased only a small amount since the early 1970's compared to the large decreases in industrial particulate emissions noted in Figure 4.

Soiling index pollution roses are given in Figure 12. While the downtown and Barton Street stations show the highest concentrations, and do show averages under northeast winds up to about 0.8 COH's, these concentrations were inflated by inversion-time measurements which were partly traffic related. The east 29105 (Nash/Kentley), west 29118 (Main West) and

TABLE 4

SOILING INDEX

1-HOUR TELEMETERED INSTRUMENTS

UNITS - COH's per 1000 linear ft. of air

Ontario Objectives - 24-hour - 1.0
1-year - 0.5

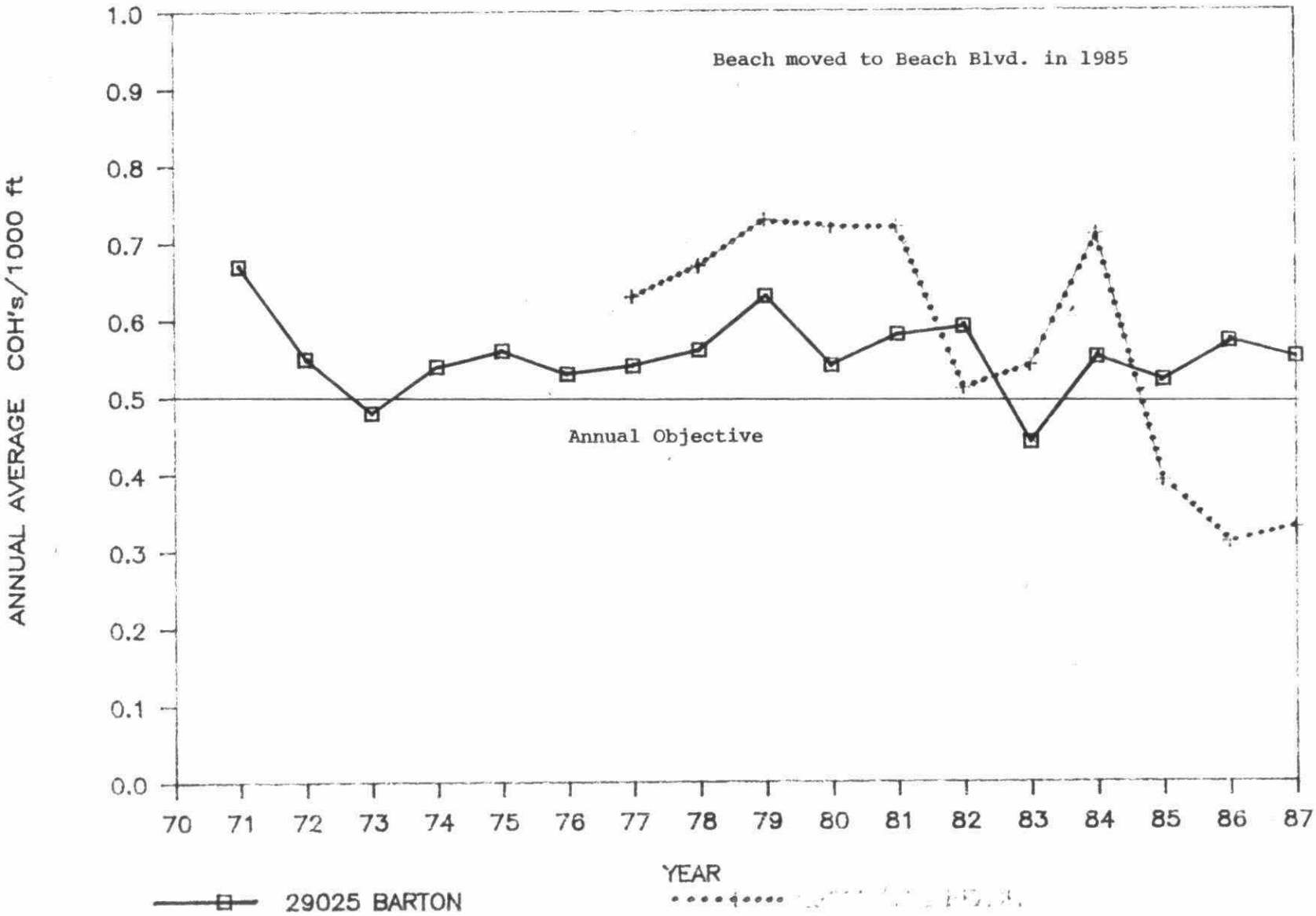
		Annual Average	Maximum 24-hour	No. of Times Above Objective 24-hour
29001 - Elgin/Kelly	1987	.45[11]	1.8	7
29001 - Hughson/Hunter	1987	.49	1.9	11
	1986	.50	1.7	10
	1985	.48	1.6	6
	1984	.60[9]	2.4	18
29008 - North Park 29102 Beach Blvd.	1987	.33	1.0	0
	1986	.31	1.3	1
	1985	.39	1.2	3
	1984*	.71	1.7	79
29025 - Barton/Sanford	1987	.55	1.8	15
	1986	.57	1.6	27
	1985	.52	1.6	10
	1984	.55	2.4	25
29105 - Nash/Kentley	1987	.40	1.3	2
	1986	.38	1.1	1
	1985	.33	1.0	0
29114 - Vickers/East 18th	1987	.36	1.4	4
	1986	.33	1.2	3
29118 - Main W./Hwy. 403	1987	.42	1.6	9
	1986	.41	1.6	9
	1985	.42[4]	1.1	3

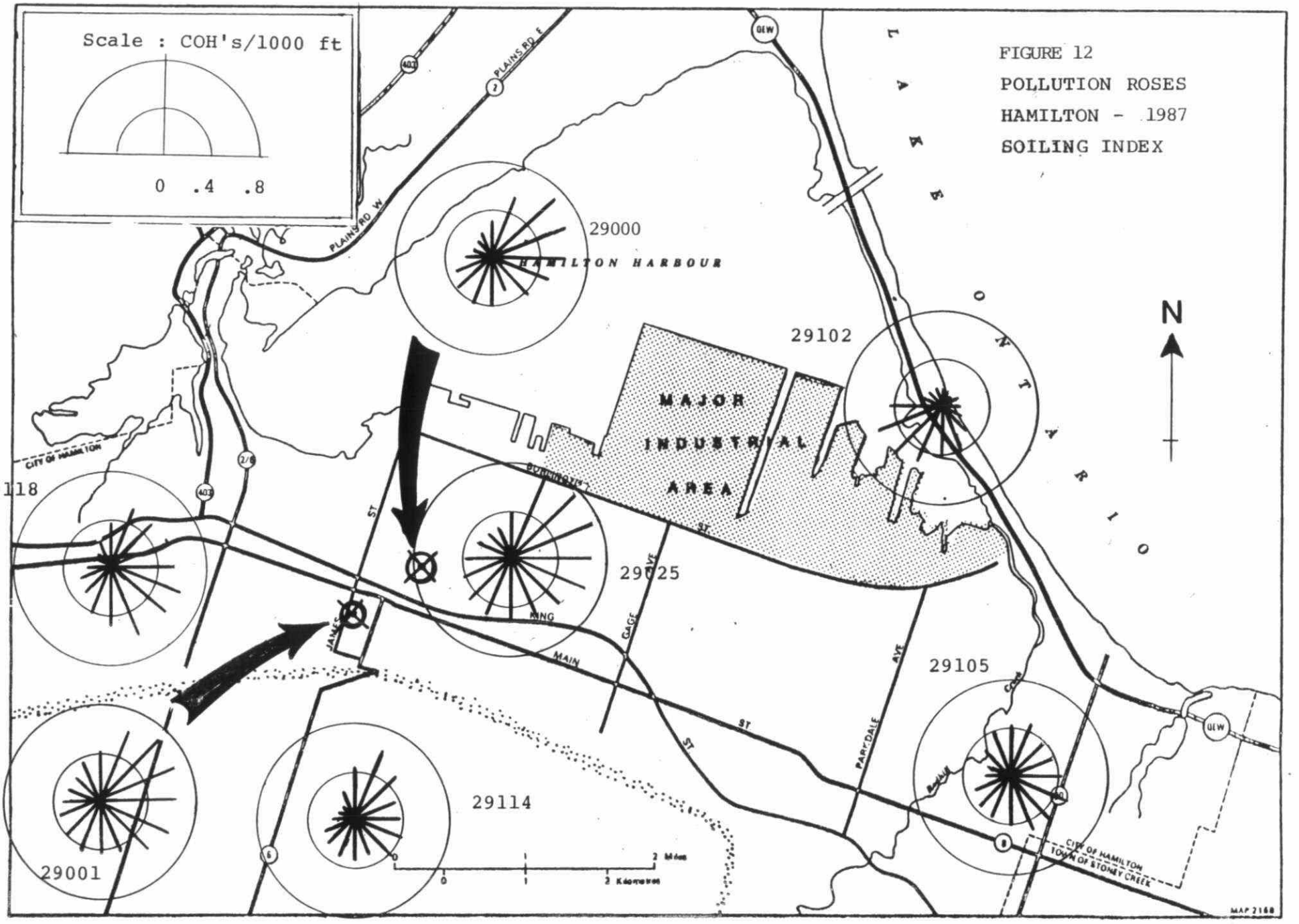
[9] - Numerical exponent refers to number of months sampled when less than 12.
* - 29008 moved to 29102 in October 1984.

FIGURE 11

SOILING INDEX YEARLY TREND

HAMILTON 1971 – 1987




Scale : COH's/1000 ft
0 .4 .8
FIGURE 12
POLLUTION ROSES
HAMILTON - 1987
SOILING INDEX
29000
HAMILTON HARBOUR
29102
MAJOR
INDUSTRIAL
AREA
N
29118
29125
29105
29114
29001
PLAINS RD E
PLAINS RD W
MAIN ST
PARKDALE AVE
CITY OF HAMILTON
TOWN OF STONEY CREEK
MAP 2168

mountain (29114 - Vickers/East 18th) stations generally did not show peaks pointing at the industries. The east station is remote from traffic, while the west station is adjacent to the Highway 403 cutoff. The southeast peaks at the station near the 403 point to this roadway. The mountain station, also remote from traffic showed low averages from most directions and a slight lower-city influence was noted for northeast winds. The Beach station, although closest to the industrial area, showed the lowest levels. It did continue to show southwest peaks (from industry) however, they were half of what they were at the old North Park station. The QEW and Beach Blvd. are still upwind during southwest winds but farther away. Peaks at rush hours were still evident in the data.

It is important to note that while traffic appears to affect the soiling index measurement more than industry, industrial emissions may still be contributing. Another fine particulate monitor, also measuring particles less than 10 microns and known as a dichotomous sampler has been used on an experimental basis. It correlates fairly well to suspended particulate results, while soiling index correlates poorly. This is probably explained by the fact that the dichotomous sampler and suspended particulate methodologies involve weight determinations, while the soiling index uses the light scattering properties of particles. Both the suspended particulate results and dichotomous results do show industrial area contributions to particulate levels, especially during inversions. The soiling index measurement however, must be retained because it is the only practical method for measuring hourly concentrations.

4.2.3Dustfall

Dustfall is that material which settles out of the atmosphere by gravity. It is collected in plastic containers during a 30 day exposure time. The collected material is weighed and expressed as a deposition rate of grams/square meter/30 days. The significance of observations is restricted to relatively local areas.

Dustfall levels in 1987 (Table 5) decreased slightly from previous years. Figure 13 depicts dustfall isopleths, and shows that a small portion of the lower city and the Beach Strip near the industrial area was encompassed by the 9.0 grams/m^2/30 days contour which represents twice our objective. Conditions in this area were quite poor. None of the 15 established stations met the yearly objective. However, three new samplers were located near existing stations to determine the representativeness of the old stations - in case there are undue local traffic effects. In all three cases, the new stations located on quiet side streets measured lower levels, below the yearly objective in two cases, although only 6 or 7 months of data were available. The 29217 - Chatham/Fanning location confirmed that the high readings at 29017 - Chatham/Frid were very localized. The 29230 - Cameo location also confirmed an impact of traffic on 29030 - Camden/Mohawk. The 29231 - Audrey station did not reveal particularly lower levels than 29031 - Concession/Upper Sherman. For both stations, all but the first samples were below the monthly objective. The Concession station showed a significant improvement from previous years, down almost 25% from 1986 levels. It is unknown what may have caused this.

As with the suspended particulate contour maps, the dustfall contour maps are not strictly a definitive representation of conditions city wide. Local influences affect some of the

TABLE 5

DUSTFALL 1987

Ontario Objectives - 1 month avg - 7.0
1 year ave - 4.5

UNITS - GRAMS/SQ. METRE/30 DAYS

	Annual Average			Maximum	Number of Months Above Objective
	1985	1986	1987	1987	1987
29001 Hughson/Hunter	8.0	6.2	5.3	8.3	3
29006 Queenston	6.3	6.4	5.7	14.5	2
29009 Kenilworth	5.7	4.6	4.0	6.7	0
29010 Burlington/Ottawa	16.9	19.9	19.7	25.6	12
29011 Burlington/Leeds	12.5	14.1	12.4	23.0	11
29012 Burlington/Wellington	9.5	8.8	6.8	13.8	4
29017 Chatham/Frid	8.8	9.7	9.9	17.8	10
29217 Chatham/Fanning	-	-	3.1[7]	4.7	0
29025 Barton/Sanford	6.2	5.9	5.0	7.6	2
29030 Camden/Mohawk	5.0	5.1	5.2	16.1	2
29230 Cameo Ave	-	-	3.9[6]	7.5	1
29031 Concession/Upper Sherman	7.7	7.1	5.5	9.2	4
29231 Audrey/East 27th	-	-	4.8[6]	11.8	1
29036 Roosevelt/Beach Rd.	16.7	18.8	15.3	24.7	12
29044 Wark/Beach Blvd.	8.6	9.3	6.7	11.1	4
29082 Leaside Rd.	7.0	8.1	7.5	12.4	5
29084 Rembe/Beach Blvd.	10.9	10.2	8.9	15.0	8
29102 Beach Blvd.	6.1	5.6	4.2	6.5	0

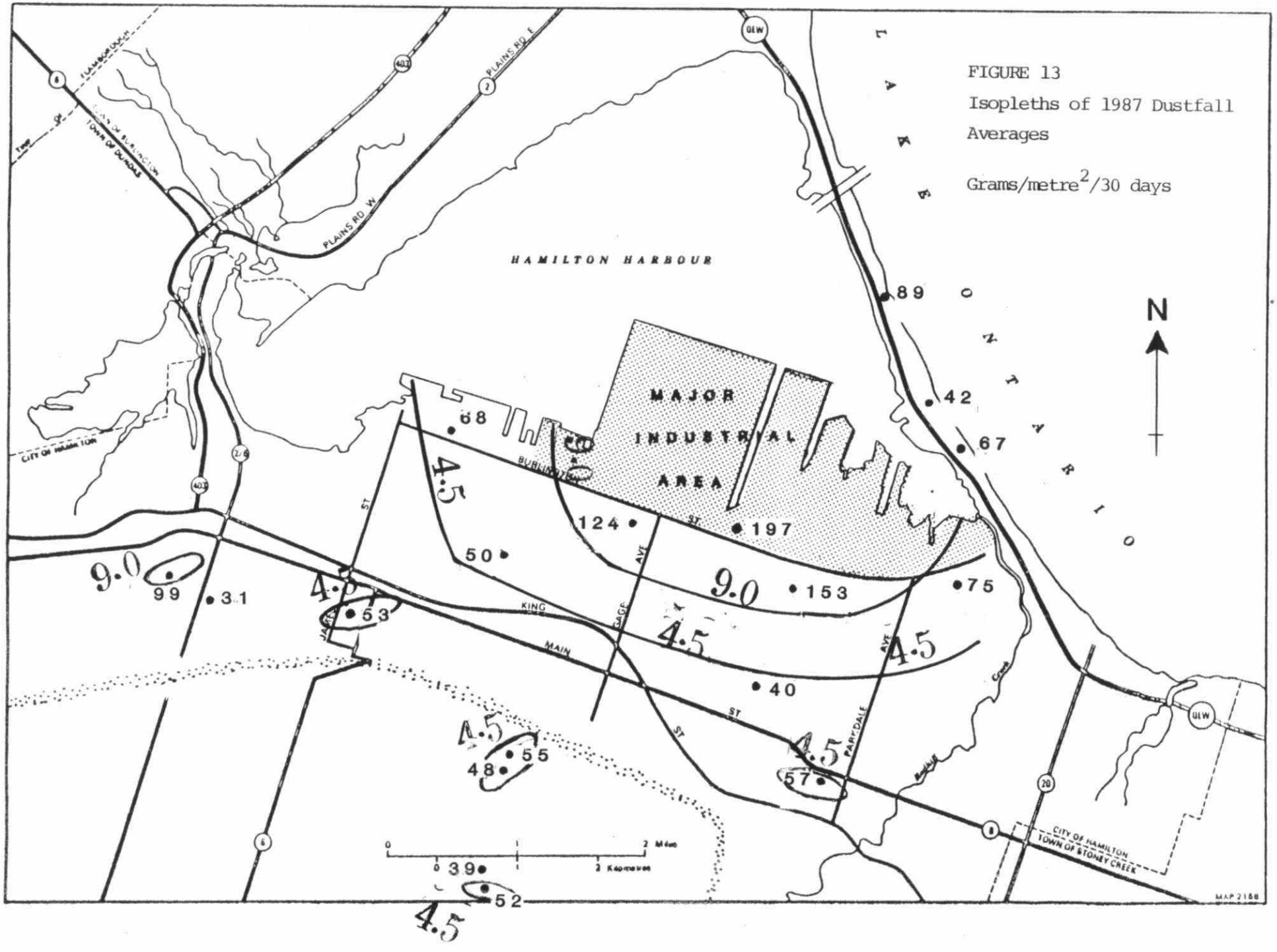


FIGURE 13
Isopleths of 1987 Dustfall Averages
Grams/metre^2/30 days
HAMILTON HARBOUR
MAJOR INDUSTRIAL AREA
LAKE ONTARIO
N
89
42
67
68
124
197
50
153
75
99
31
53
40
48
55
57
39
52
9.0
4.5
KING
MAIN
PARKDALE
PLAINS RD E
PLAINS RD W
CITY OF HAMILTON
TOWN OF STONEY CREEK
MAP 2188

stations and the measurement is rather imprecise. As well, some of the small contours drawn have no scientific validity. They are only drawn to indicate that particular stations were subject to local influences, unrepresentative of the general area.

Dustfall objectives are based on visible deposit of dust rather than health effects. Figure 4 shows that the levels throughout the city have remained virtually unchanged throughout the 1970's and 1980's. This is significant considering the reductions in industrial process emissions and the correspondingly large reductions in suspended particulate concentrations noted in the same graph. Fugitive dust sources such as road dust, stock piles, unpaved areas, vehicle emissions, etc. are probably important in explaining this observation.

As mentioned, road traffic is a major source of the dust at several of the stations. The locations on Concession Street at Upper Sherman (29031) and Mohawk Road at Camden (29030) recorded higher than expected loadings, probably due to the heavy traffic which passes directly by the stations. On Ottawa Street (29010), construction activities at Dofasco have resulted in extremely high concentrations being observed, of which a large portion can probably be ascribed to increased heavy truck traffic and quantity of dirt tracked onto the street near the station. The station at Chatham/Frid (29017) is also significantly affected by local fugitive sources such as road traffic and unpaved lots.

Control efforts such as the use of chemical sealants, road paving and road washing have taken place within some company properties in the industrial area to control fugitive dust emissions. However, little improvement in overall dustfall has occurred. Measurements on company properties indicate

that fugitive dust emissions are still considerable. More intensive control efforts will be necessary. These may include measures to reduce dirt trackout onto streets and increased planting of vegetation.

4.3 Sulphur Dioxide

Most sulphur dioxide (SO_2) emissions in Hamilton stem from industrial sources. A smaller portion is accounted for by fuel burning in domestic space heating. Data for six stations are summarized in Table 6, which lists objective values that are based on vegetation damage (hourly and yearly) and health effects in conjunction with suspended particulate (daily).

Sulphur dioxide trends from the Barton and Beach stations since 1970 are illustrated in Figure 14. In 1987, as in the past several years, the concentrations were acceptable based on the yearly and daily objectives. There was one reading above the hourly objective, the first such occurrence in Hamilton since 1978. The incident occurred on August 14, at 29114 - Vickers/East 18th on the mountain. Other stations also recorded elevated hourly readings on this day. The winds were southerly and the SO_2 was traced back to the Nanticoke Generating Station, about 50 km away.

The pollution roses for the stations given in Figure 15 confirm that the industrial area is the prime source of SO_2 in the city. The east and west stations show only small industrial influence. Local space heating likely affects these stations. The mountain station recorded levels fairly similar to the downtown stations except that the northeast peaks were smaller.

TABLE 6

SULPHUR DIOXIDE

Ontario Objectives: 1-hour - .25
24-hour - .10
1-year - .02

UNITS - PARTS PER MILLION

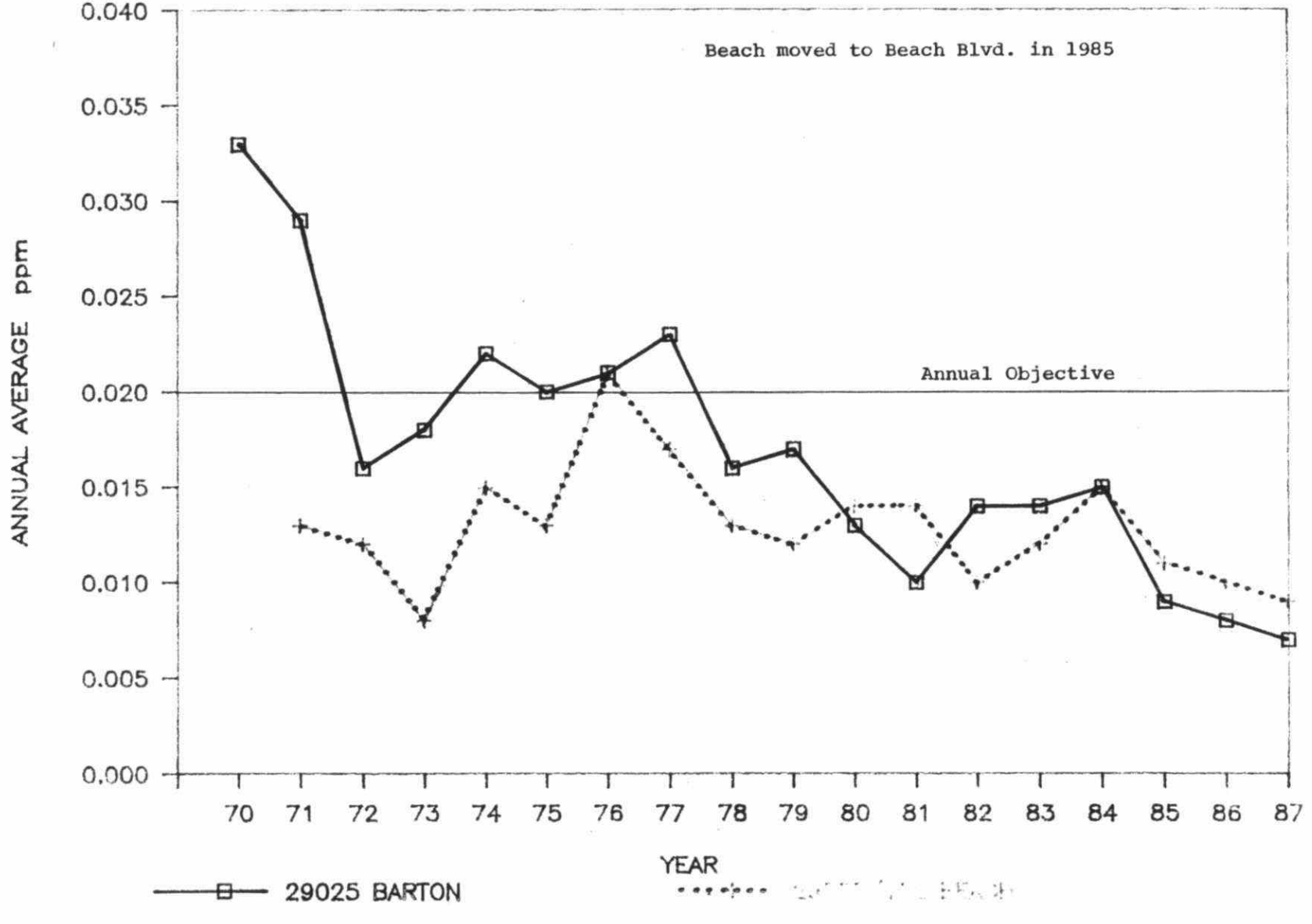
		Annual Average	Maximum 1-hour	Maximum 24-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 24-hour
29000 - Elgin/Kelly	1987	.009[11]	.24	.06	0	0
29008 - North Park/	1987	.009	.17	.05	0	0
29102 - Beach Blvd.	1986	.010	.12	.07	0	0
	1985	.011	.12	.06	0	0
	1984*	.015	.13	.07	0	0
29025 - Barton/	1987	.007	.15	.04	0	0
Sanford	1986	.008	.14	.05	0	0
	1985	.009	.11	.06	0	0
	1984	.015	.18	.07	0	0
29105 - Nash/	1987	.005	.14	.03	0	0
Kentley	1986	.006	.11	.03	0	0
	1985	.004	.16	.02	0	0
29114 - Vickers/	1987	.008	.36	.06	1	0
East 18th	1986	.009	.11	.05	0	0
29118 - Main W./	1987	.006	.19	.03	0	0
Hwy. 403	1986	.007	.24	.04	0	0
	1985	.005[6]	.06	.03	0	0

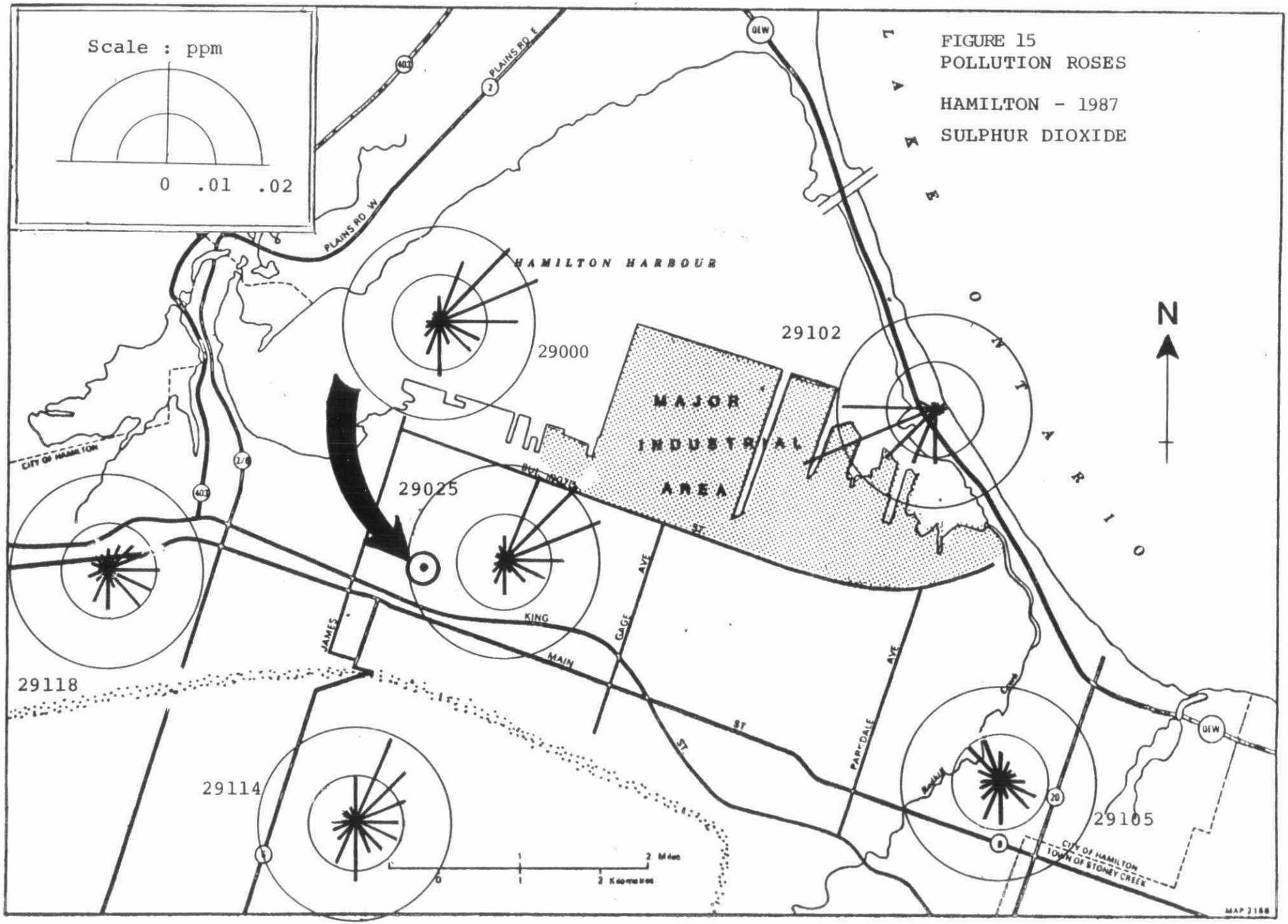
* - 29008 moved to 29102 in October 1984.
[6] - Six months of sampling (July - December).

FIGURE 14

SULPHUR DIOXIDE YEARLY TREND

HAMILTON 1970 – 1987




Scale : ppm
0 .01 .02
FIGURE 15
POLLUTION ROSES
HAMILTON - 1987
SULPHUR DIOXIDE
HAMILTON HARBOUR
29000
29102
29025
29118
29114
29105
MAJOR INDUSTRIAL AREA
N
PLAINS RD W
PLAINS RD E
CITY OF HAMILTON
KING
MAIN
JAMES
GAGE AVE
PARKDALE AVE
CITY OF HAMILTON
TOWN OF STONEY CREEK
2 Miles
2 Kilometres
MAP 2188

4.4 Total Reduced Sulphur

These gases are comprised of hydrogen sulphide (H_2S), the "rotten egg" gas and other sulphur compounds and the mixture is referred to as total reduced sulphur (TRS). There are no general objectives for TRS, however an hourly objective for H_2S of 20 ppb may be compared to the observed values since most emissions are thought to contain H_2S. The data given in Table 7 are also compared to the 10 ppb level - an approximate odour threshold for H_2S. TRS is measured at four stations - Barton, Elgin, Beach and the mountain.

The major sources of hydrogen sulphide and related sulphur compounds are the steel industry's coke ovens and related by-products operations, certain slag quenching processes, a tar plant and under upset conditions, a local manufacturer of carbon black. The sewage treatment plant is another potential source of odours but only during certain upset conditions.

In 1987, significant improvements in TRS were observed at the Barton and mountain stations beginning in May. This improvement was related to Stelco Inc. replacing direct contact coolers in the coke oven by-product area with indirect coolers in April. The Barton station measured only 45 hours above 10 ppb (only 10 from May onwards) compared to 106 hours in 1986. The mountain station measured only 21 such hours (only 2 from May onwards) compared to 46 hours in the final 3 months of 1986, when the instrument was first installed. The new Elgin/Kelly station downtown commenced TRS measurements in February 1988 and measured only 12 hours over 10 ppb.

Figure 16 displays the trend of 10 ppb exceedences per year at the Barton and Beach stations. The Barton station clearly shows a decreasing trend during the 1980's with a dramatic decrease observed in 1987.

TABLE 7

TOTAL REDUCED SULPHUR

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 20 (Hydrogen Sulphide)

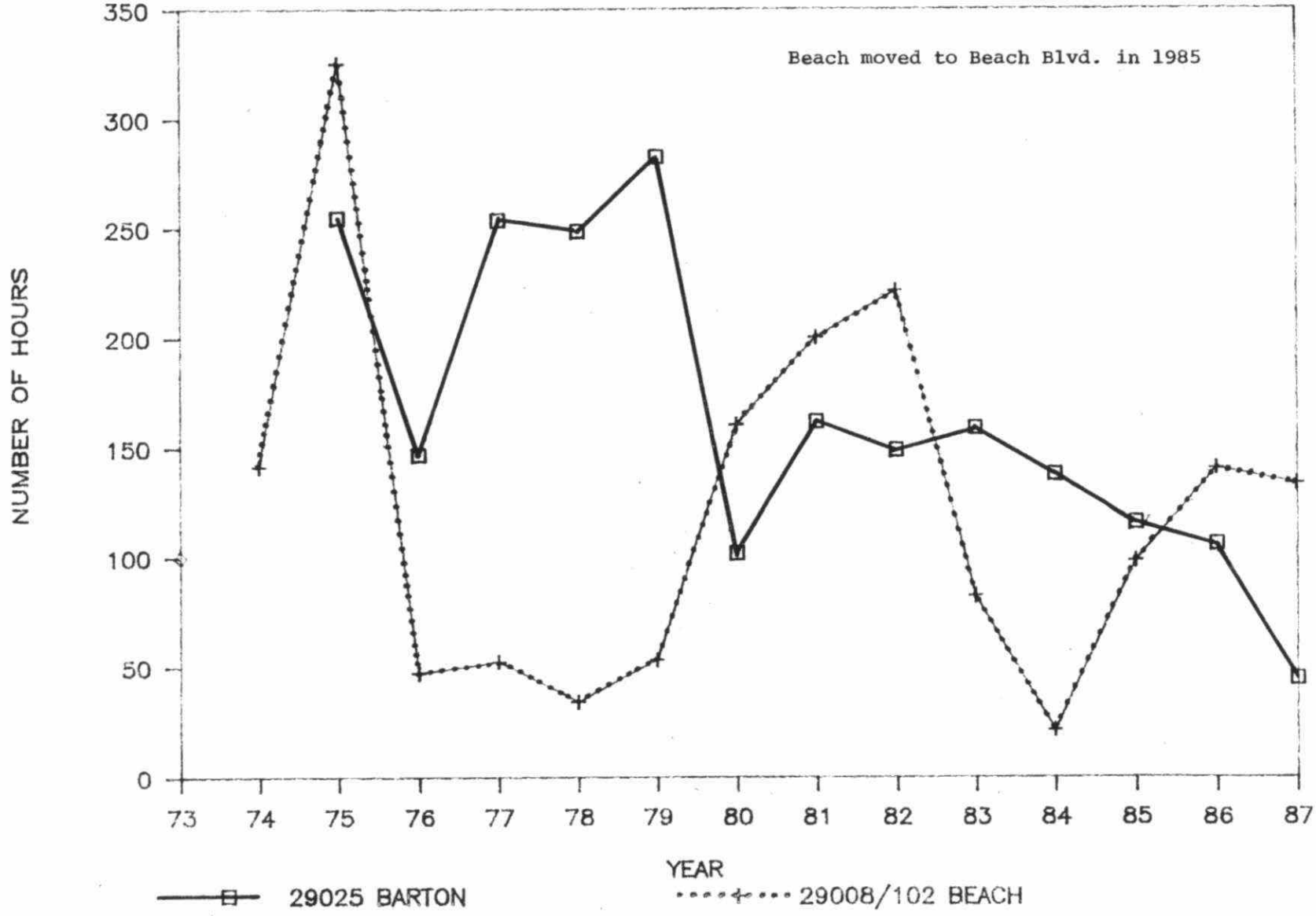
		Annual Average	Maximum	Number of Hours Above 10ppb	20ppb
29000 - Elgin/Kelly	1987	0.8^{11}	14	12	0
29008 - North Park/ Beach Blvd.	1987	1.6	33	134	15
29102	1986	1.3	42	141	18
	1985	1.0	37	99	15
	1984*	0.9	41	22	9
29025 - Barton/ Sanford	1987	0.9	30	45	6
	1986	1.4	64	106	12
	1985	1.4	56	116	16
	1984	1.8	44	138	20
29114 - Vickers/ East 18th	1987	0.8	19	21	0
	1986	0.9^{3}	24	42	4

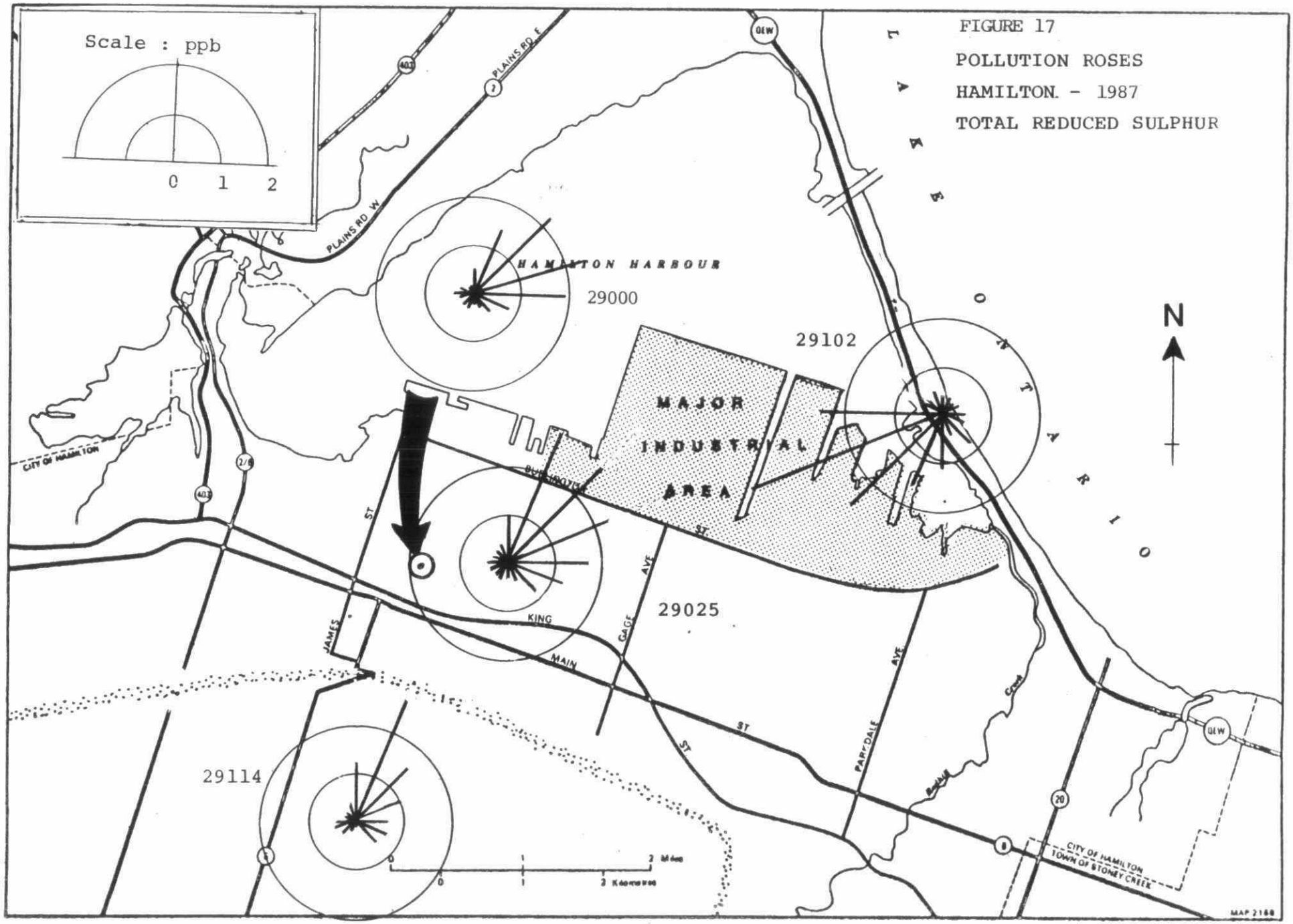
*29008 moved to 29102 in October 1984.
^{11} - Numerical exponent refers to number of months sampled when less than 12.

FIGURE 16

TRS EXCEEDENCE TREND – HAMILTON

HOURS OVER 10 PPB




Scale : ppb
0 1 2
FIGURE 17
POLLUTION ROSES
HAMILTON - 1987
TOTAL REDUCED SULPHUR
HAMILTON HARBOUR
29000
29102
MAJOR INDUSTRIAL AREA
29025
29114
LAKE ONTARIO
N
PLAINS RD W
PLAINS RD E
CITY OF HAMILTON
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
CITY OF HAMILTON
TOWN OF STONEY CREEK
0 2 Miles
0 3 Kilometres
MAP 2188

A gradual decline is also evident in the graph for Beach Blvd. but that location did not show the same dramatic improvement in 1987 as Barton Street. It is worth noting that the station was moved 1 km south, closer to Dofasco in 1985 and more in line with prevailing winds from that company. Stelco's effect on the Beach is limited by distance. The Beach station recorded 134 hours over 10 ppb in 1987 compared to 141 hours in 1986. Hourly data indicate that Dofasco Ltd. was the prime source affecting the Beach station. That company has been experimenting with methods of reducing emissions from slag quenching. The Carbochem plant also affects the Beach area but to a lesser degree. That company is now operating under a Control Order which is to be completed in 1989.

Not surprisingly, the TRS pollution roses for the three stations given in Figure 17 point strongly toward the industrial area. Special monitoring surveys have and are continuing to be carried out to determine main sources of the elevated ambient concentrations in order to plan the most effective abatement strategies.

In addition to the Carbochem Control Order, the Ministry will continue to work with both Stelco and Dofasco to further reduce their TRS emissions.

4.5 Carbon Monoxide

The major source of carbon monoxide is the automobile although there are also some contributions from industry. Due to automotive emission controls, the levels measured at Barton Street (moved to Elgin/Kelly in 1987) decreased greatly since the 1970's (Figure 18). In 1987, the levels were similar to the previous few years and were well below the objectives which are based on health effects. Data are given in Table 8.

TABLE 8

CARBON MONOXIDE

UNITS - PARTS PER MILLION

Ontario Objective: 1-hour - 30
8-hour - 13

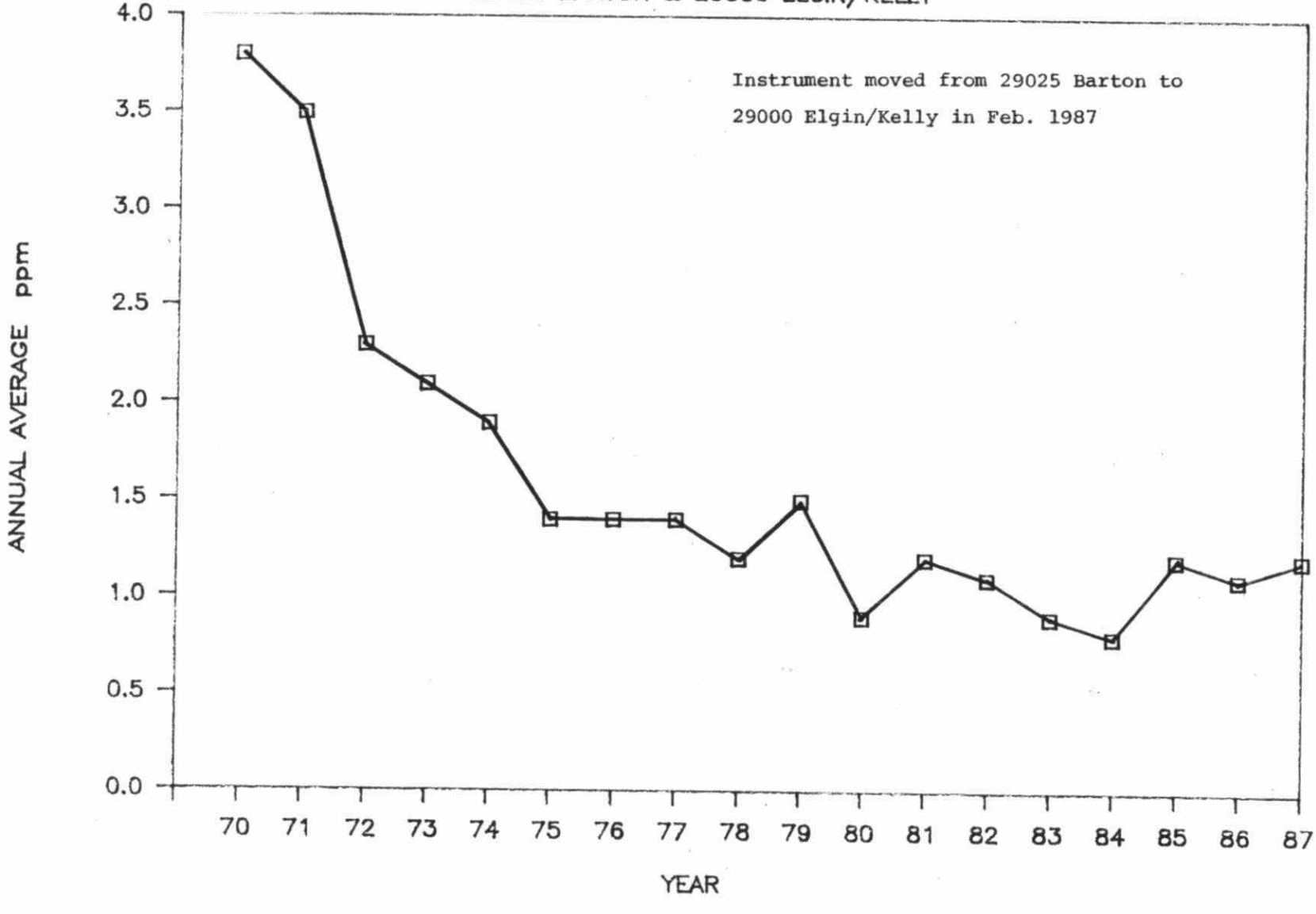
		Annual Average	Maximum 1-hour	Maximum 8-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 8-hour
29008 - North Park/ 29102 - Beach Blvd	1987	0.3	10	3	0	0
	1986	0.3	7	2	0	0
	1985	0.3	7	3	0	0
	1984*	0.3	5	2	0	0
29025 - Barton/ Sanford	1987+	1.2	8	5	0	0
	1986	1.1	12	6	0	0
29000 - Elgin/kelly	1985	1.2	10	4	0	0
	1984	0.8	16	6	0	0

*29008 moved to 29102 in October 1984.
+29025 moved to 29000 in February 1987.

FIGURE 18

CARBON MONOXIDE YEARLY TREND

29025 BARTON & 29000 ELGIN/KELLY



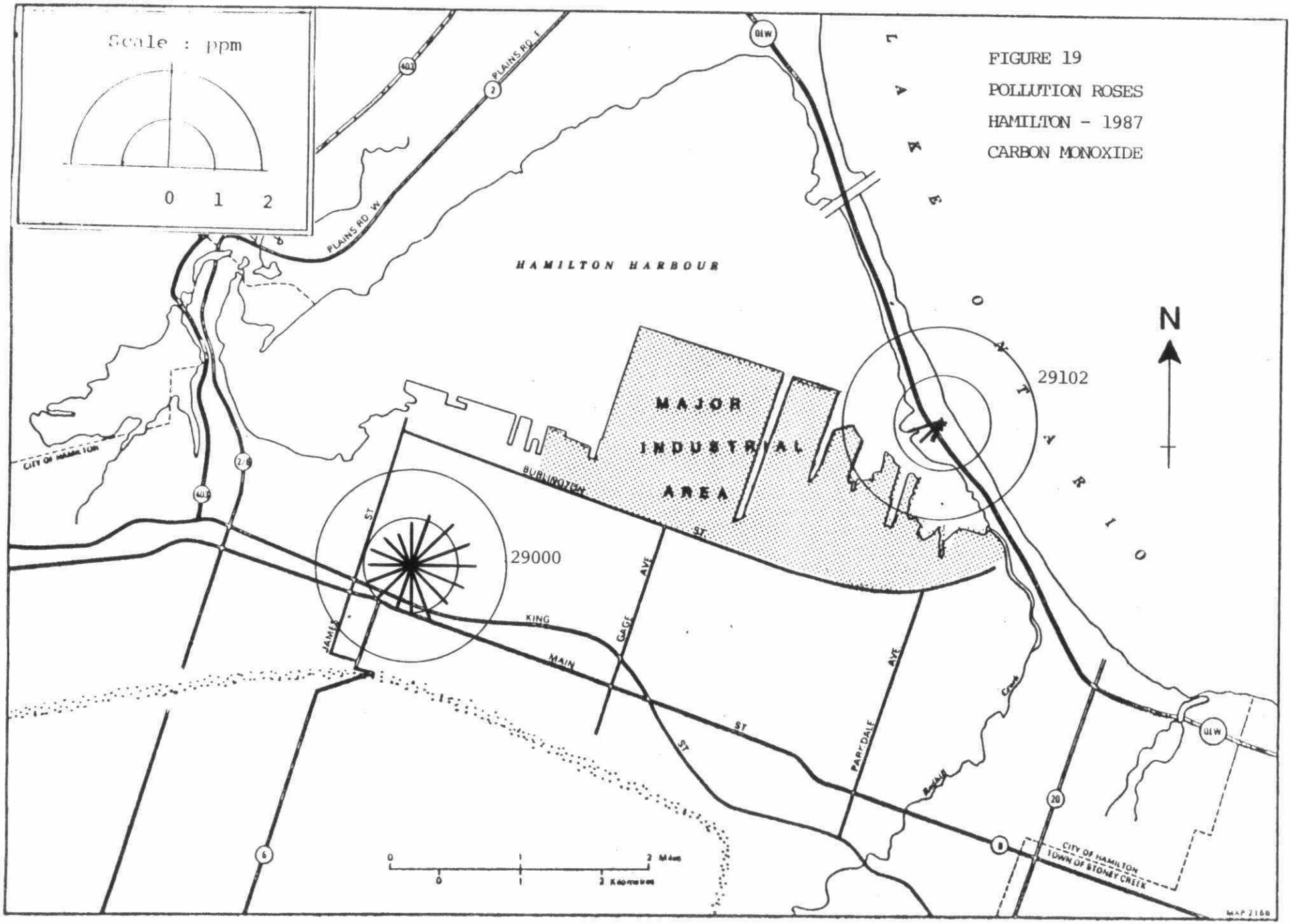


FIGURE 19
POLLUTION ROSES
HAMILTON - 1987
CARBON MONOXIDE

A carbon monoxide analyzer was installed in the North Park station in January 1984. Concentrations at North Park throughout 1984 and at Beach Blvd. in 1985-87 were lower than at Barton Street, explained by the fact that the high speed traffic on the QEW generates less carbon monoxide than the low speed traffic on Barton Street[3], and that the Beach Blvd. traffic load is much less than Barton Street - almost half[4].

The pollution roses given in Figure 19 indicate that concentrations at the new Elgin/Kelly station were uniform for all wind directions, while Beach Blvd.'s highest averages (albeit very low) were from the southwest.

4.6 Oxides of Nitrogen

The primary source of oxides of nitrogen are high temperature combustion sources including the automobile. The most abundant oxides are nitric oxide (NO) and nitrogen dioxide (NO_2). Nitric oxide is a direct emission which is then oxidized in the atmosphere to form nitrogen dioxide. Both pollutants were monitored continuously at Barton/ Sanford, Main West, and Beach Blvd. At each station, a single instrument makes measurements of NO, NO_2 and total nitrogen oxides. Nitric oxide is measured directly, and the total oxides are measured by internally converting all other nitrogen oxides to nitric oxide. The instrument then determines nitrogen dioxide to be the difference between the first two measurements.

Objectives exist only for nitrogen dioxide and these are based on odour threshold levels (hourly) and health effects (24-hourly). Other adverse effects occurring at much higher levels include vegetation damage, reduced visibility and corrosion of metals. The objectives were not exceeded in 1987 similar to previous years.

TABLE 9

NITROGEN DIOXIDE

UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .20
24-hour - .10

		Annual Average	Maximum 1-hour	Maximum 24-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 24-hour
29008 - North Park/ 29102 - Beach Blvd.	1987	.022	.11	.06	0	0
	1986	.023	.12	.12	0	0
	1985	.023	.08	.06	0	0
	1984*	.026	.09	.07	0	0
29025 - Barton/ Sanford	1987+	.027	.14	.06	0	0
	1986	.027	.10	.07	0	0
29000 - Elgin/Kelly	1985	.025	.11	.06	0	0
	1984	.029	.13	.06	0	0
29118 - Main W./ Hwy. 403	1987	.018	.10	.07	0	0
	1986	.018	.12	.08	0	0
	1985	.019[6]	.08	.04	0	0

* - 29008 moved to 29102 in October 1984.
[6] - Six months of sampling (July - December).
+ - 29025 moved to 29000 in February 1987.

TABLE 10

NITRIC OXIDE

UNITS - PARTS PER MILLION

		Annual Average	Maximum 1-hour	Maximum 24-hour
29008 - North Park/ 29102 - Beach Blvd.	1987	.021	.42	.14
	1986	.023	.47	.23
	1985	.020	.51	.09
	1984*	.056	.52	.22
29025 - Barton/ Sanford	1987+	.017	.47	.15
	1986	.021	.50	.15
29000 - Elgin/Kelly	1985	.019	.51	.11
	1984	.019	.41	.12
29118 - Main W./ Hwy. 403	1987	.034	.57	.22
	1986	.029	.53	.20
	1985	.033[6]	.92	.15

* - 29008 moved to 29102 in October 1984.
[6] - Six months of sampling (July - December).
+ - 29025 moved to 29000 in February 1987.

Data for nitrogen dioxide are given in Table 9 and yearly trends since 1975 are illustrated in Figure 20. Both Barton and Beach stations showed similar concentrations to previous years but slightly higher than at the west end site 29118 on Main Street West, indicating a small contribution from industry. A leveling off in concentrations at the two established stations is evident although a small decline is still occurring.

Data for nitric oxide are given in Table 10 and yearly trends for Beach and Barton (moved to Elgin) are given in Figure 22. Note the abrupt decrease in levels at Beach following the move to 29102 in 1985. The station is now much less affected by vehicle emissions. The new Main Street West site recorded higher levels in 1987 than the other two; it is being affected by traffic on Main Street West and the Highway 403 cutoff.

Pollution roses for the two measurements are given in Figures 21 and 23. The roses for NO_2 seem to indicate an equal contribution from industry and traffic, particularly by Elgin/Kelly, but since NO_2 is not a direct emission, sources are difficult to pinpoint. It is clear that NO levels at all stations were due mostly to traffic.

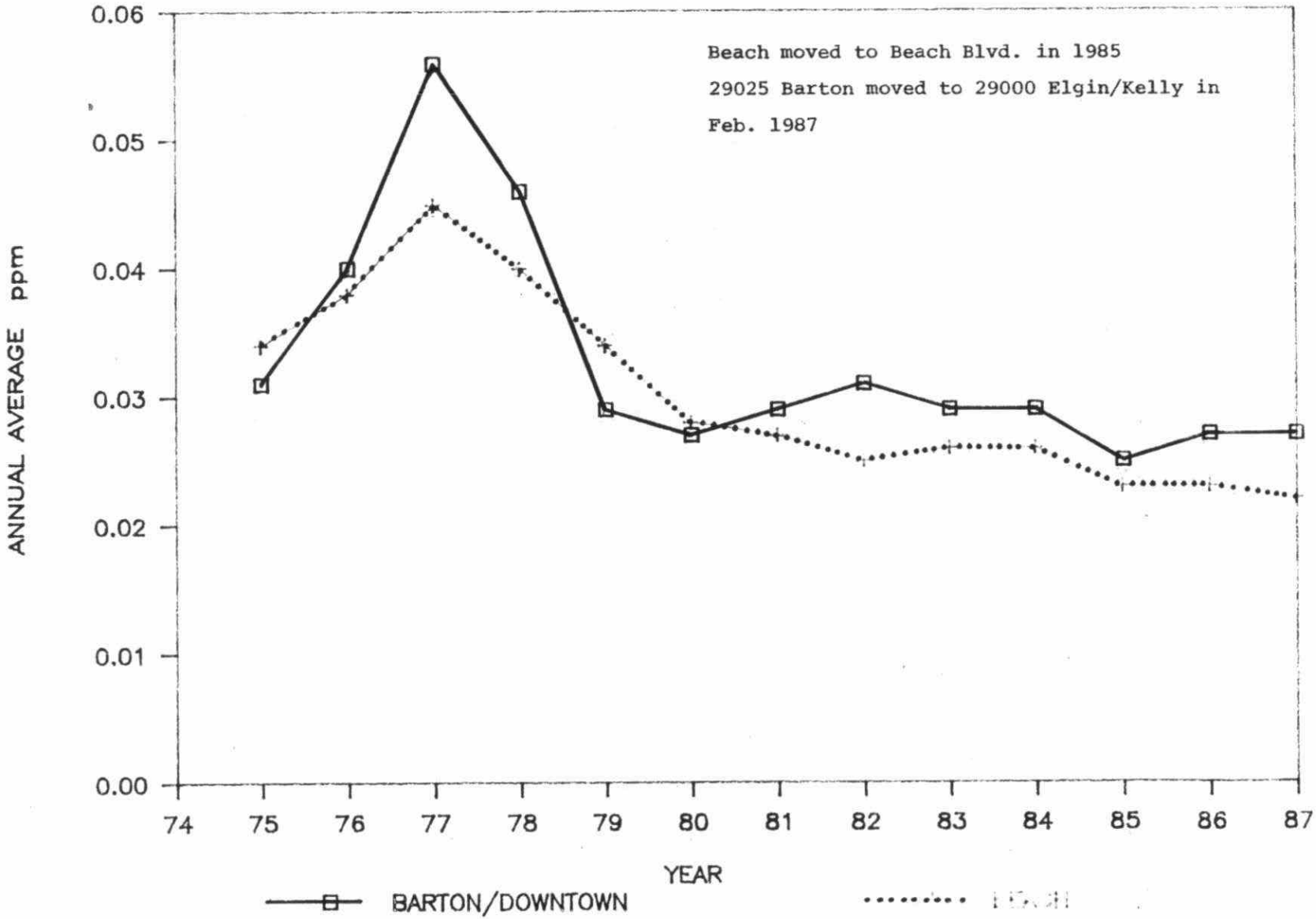
Highest NO levels were measured at 29118 (Main West), and the largest peaks point towards the Hwy. 403 cutoff and Main St. W. Elgin/Kelly also shows highest levels for southeast/northeast, probably from Wilson and Cannon Streets. The southwest peaks for 29102 (Beach Blvd.) point mainly to Beach Blvd. and the QEW, although the industries are also upwind.

Oxides of nitrogen are also an important factor in the photochemical cycle of ozone in the atmosphere. This will be discussed in the next section of this report.

FIGURE 20

NITROGEN DIOXIDE YEARLY TREND

HAMILTON 1975 – 1987



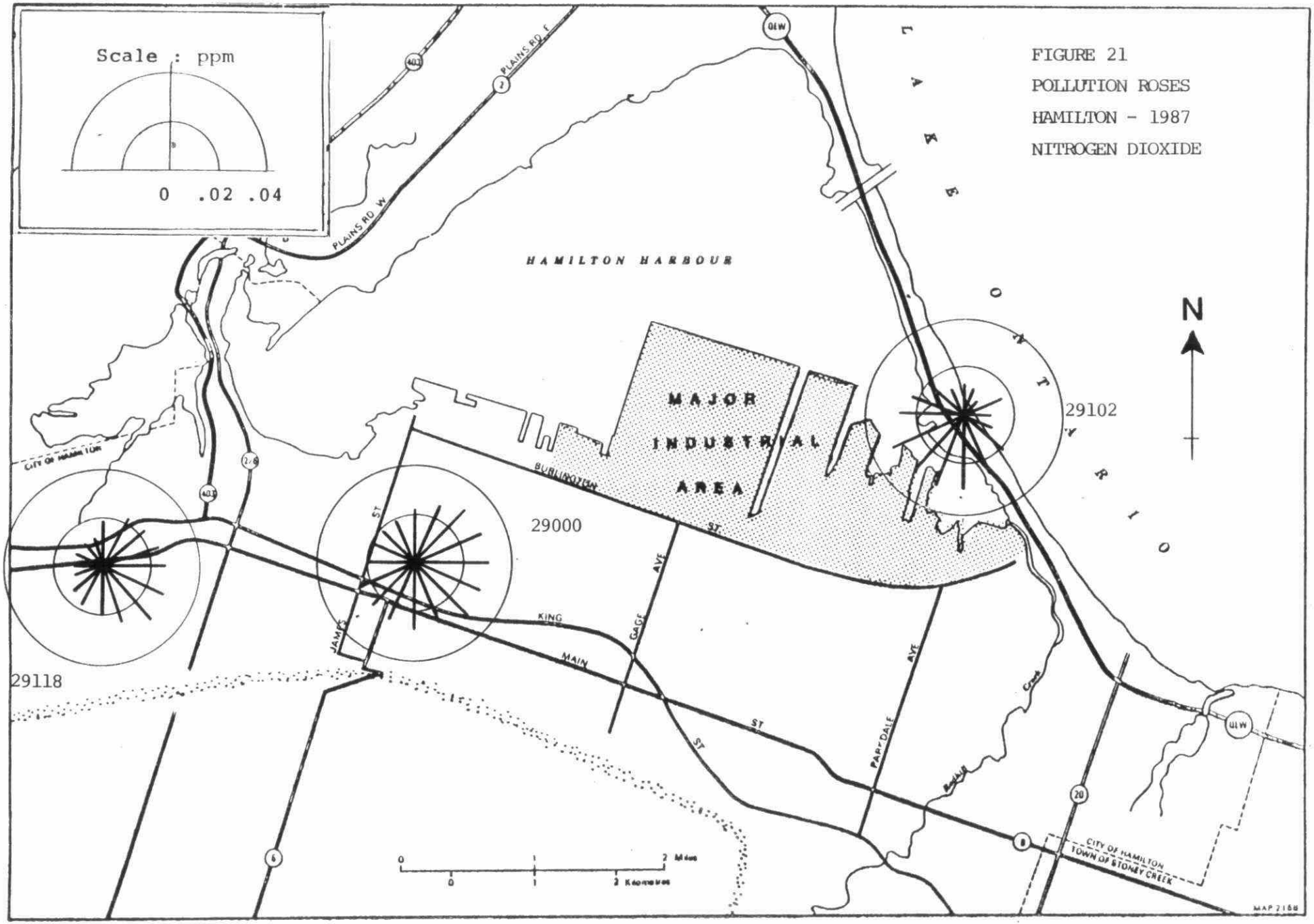
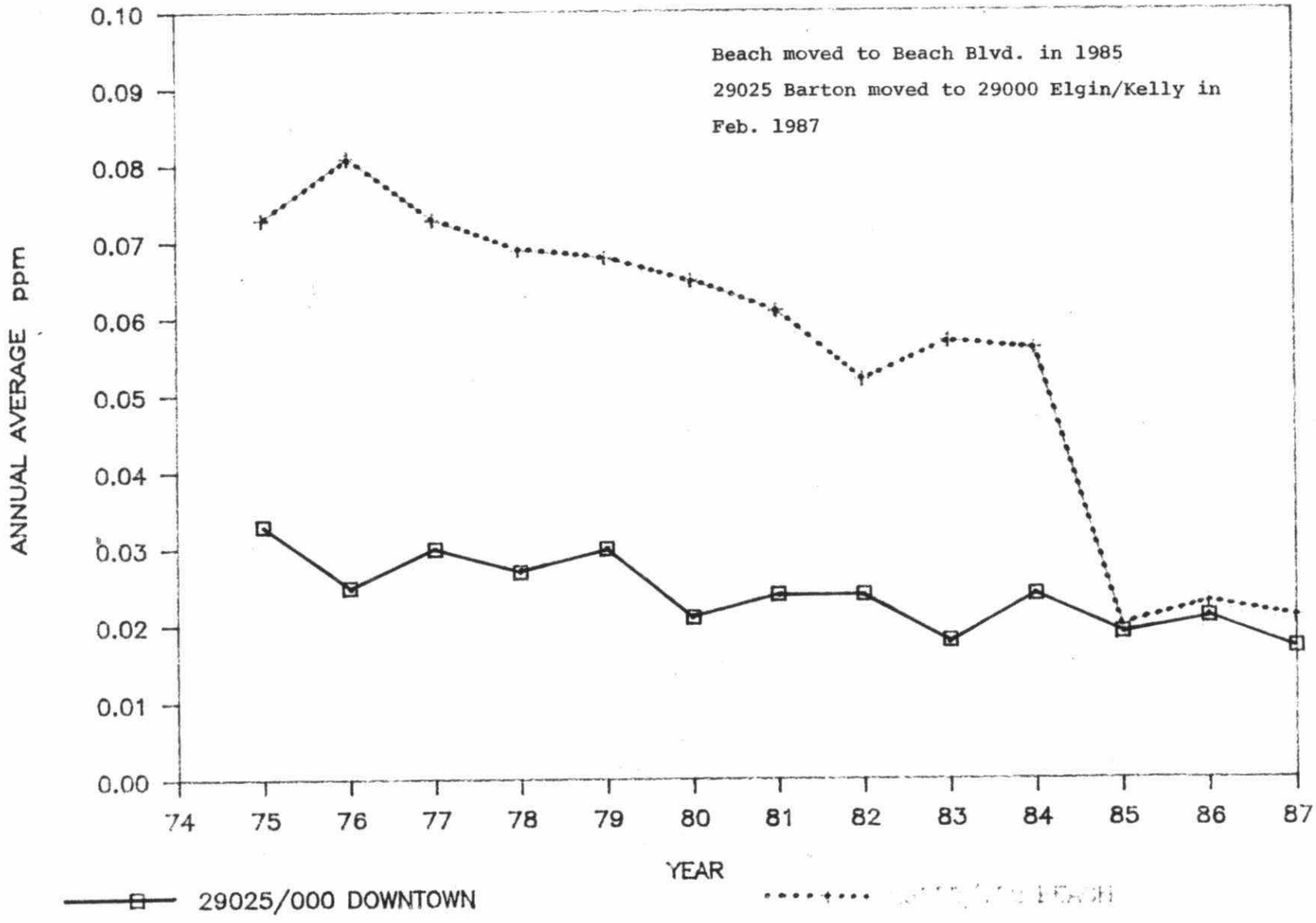


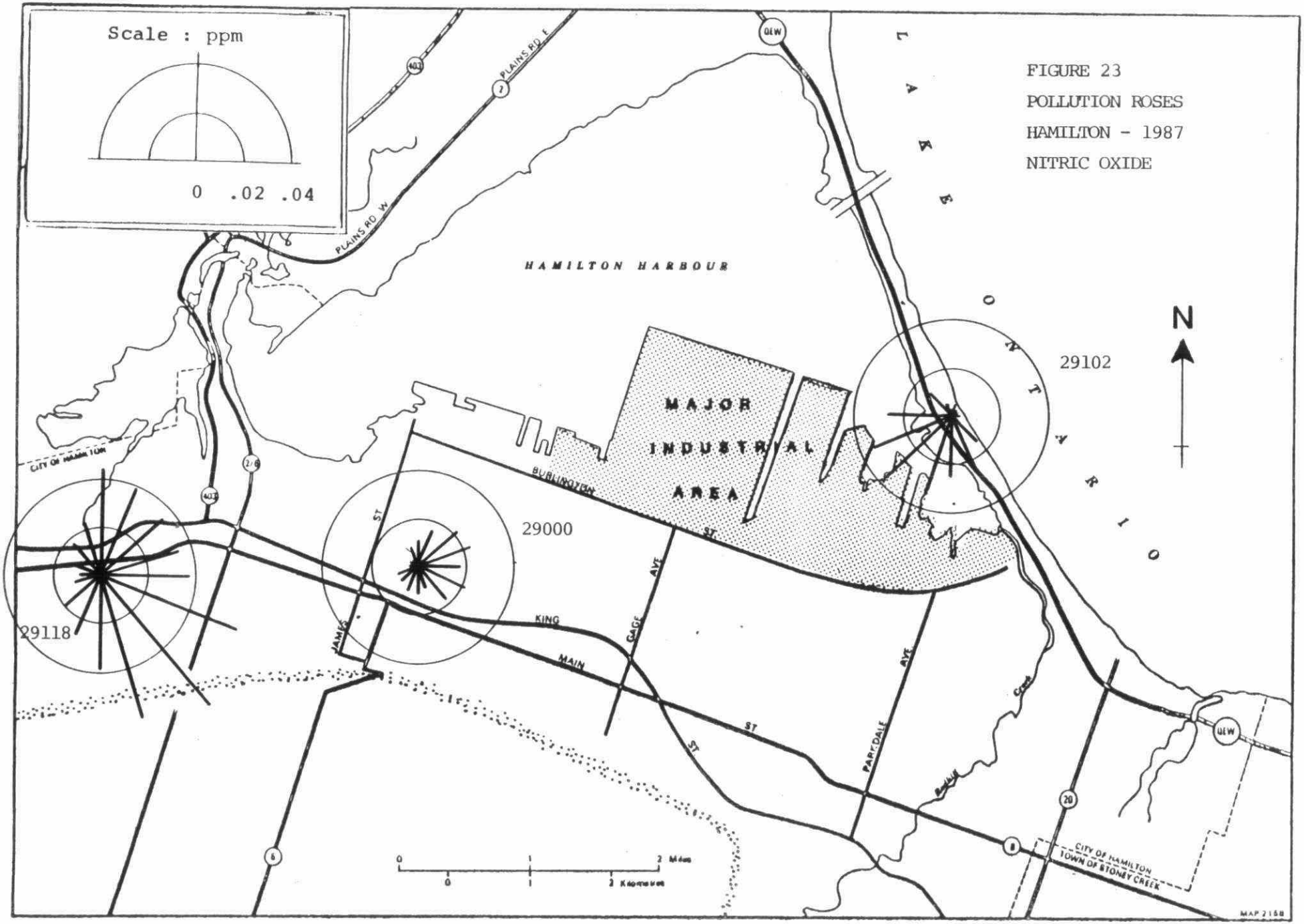
FIGURE 21
POLLUTION ROSES
HAMILTON - 1987
NITROGEN DIOXIDE

FIGURE 22

NITRIC OXIDE YEARLY TREND

HAMILTON 1975 – 1987




Scale : ppm
0 .02 .04
FIGURE 23
POLLUTION ROSES
HAMILTON - 1987
NITRIC OXIDE
HAMILTON HARBOUR
LAKE ONTARIO
MAJOR INDUSTRIAL AREA
29102
29000
29118
N
PLAINS RD E
PLAINS RD W
BURLINGTON ST
KING ST
MAIN ST
GAGE AVE
PARKDALE AVE
CITY OF HAMILTON
TOWN OF STONEY CREEK
MAP 2168

4.7 Ozone

Oxidants are produced by photochemical reactions involving oxides of nitrogen, hydrocarbons and sunlight. Ozone accounts for most of the oxidants produced. The sources of the precursor pollutants are mainly industrial and automotive. The rate of oxidant production is dependent on quantity of precursor pollutants, temperature and intensity of sunlight.

Ozone is known to cause respiratory problems, and at very elevated concentrations, people can experience adverse health effects. Ozone is also injurious to different types of vegetation including certain tobacco, bean and tomato crops. The one-hour objective for ozone (80 ppb) is based on such vegetation effects.

Ozone concentrations follow very definite annual and daily trends. Highest levels occur during the summer (May - September), and the daily maxima usually occur during late afternoon. Both patterns are directly related to temperature and the amount and intensity of sunlight.

Ozone was measured at the Elgin/Kelly station, at the east site 29105 (Nash/Kentley), the west site 29118 (Main West) and mountain station 29114 (Vickers/E 18th). Data is summarized in Table 11 while yearly trends at Barton (moved to Elgin) are illustrated in Figure 24.

In 1987, levels tended to be higher than previous years and fairly uniform City-wide. However, highest concentrations were recorded on the mountain. This station recorded the greatest number of hours over the hourly objective of 80 ppb - 85 hours while the east end measured 69 hours. A lower number of hours were measured at the Elgin and Main West sites, mainly because vehicle emissions nearby tended to

TABLE 11

OZONE

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 80

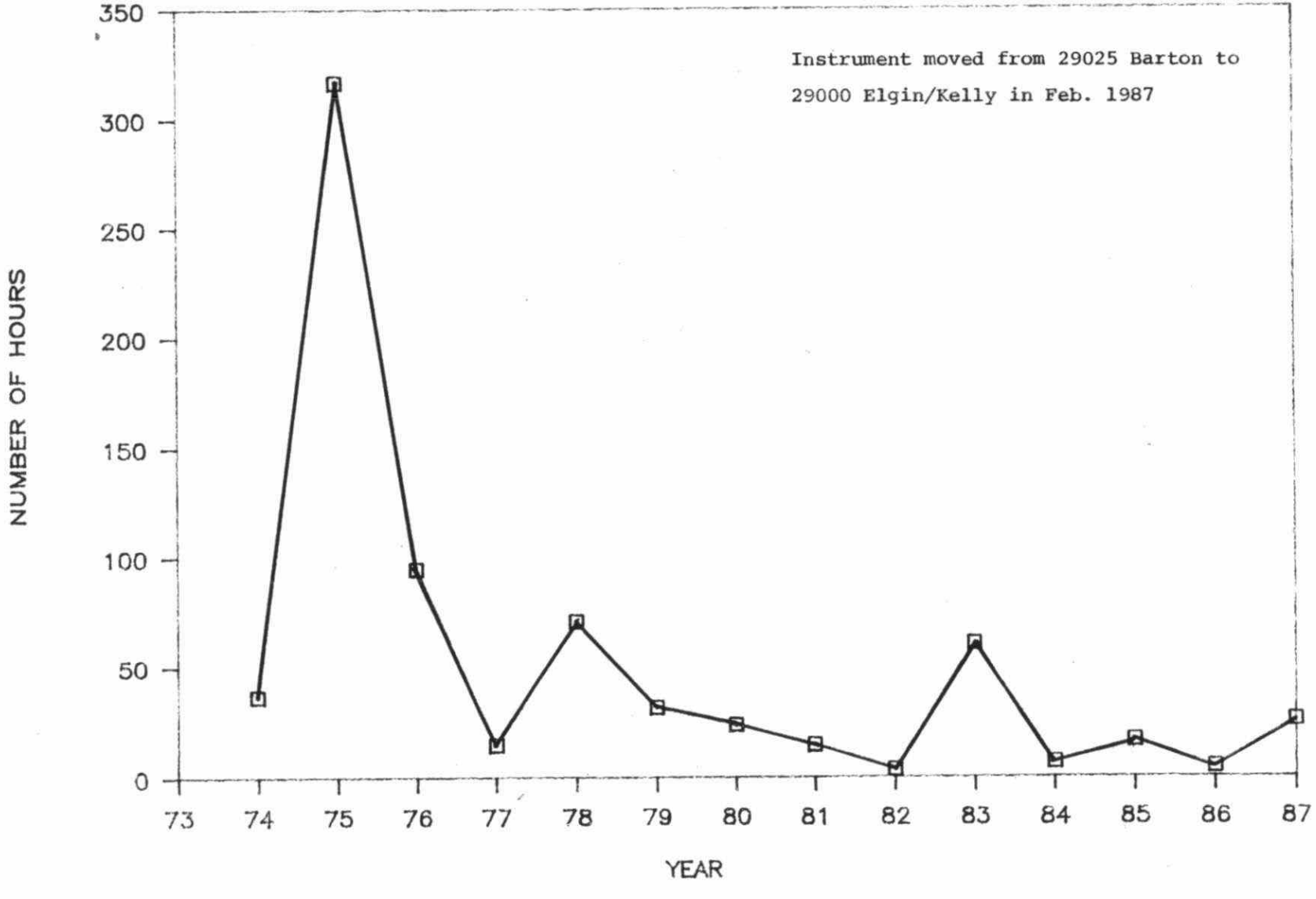
		Annual Average	Maximum - 1 hour	No. of Hours Above Objective
29025 - Barton/ Sanford	1987*	15.2	105	24
	1986	16.3	88	5
29000 - Elgin/Kelly	1985	19.0	96	17
	1984	18.1	95	7
29105 - Nash/ Kentley	1987	19.2	111	69
	1986	19.2	96	11
	1985	23.0^{11}	104	23
29114 - Vickers/ East 18th	1987	19.8	114	85
	1986	20.1	94	34
29118 - Main W./ Hwy. 403	1987	14.3	103	36
	1986	15.0	85	3
	1985	17.9^{6}	99	23

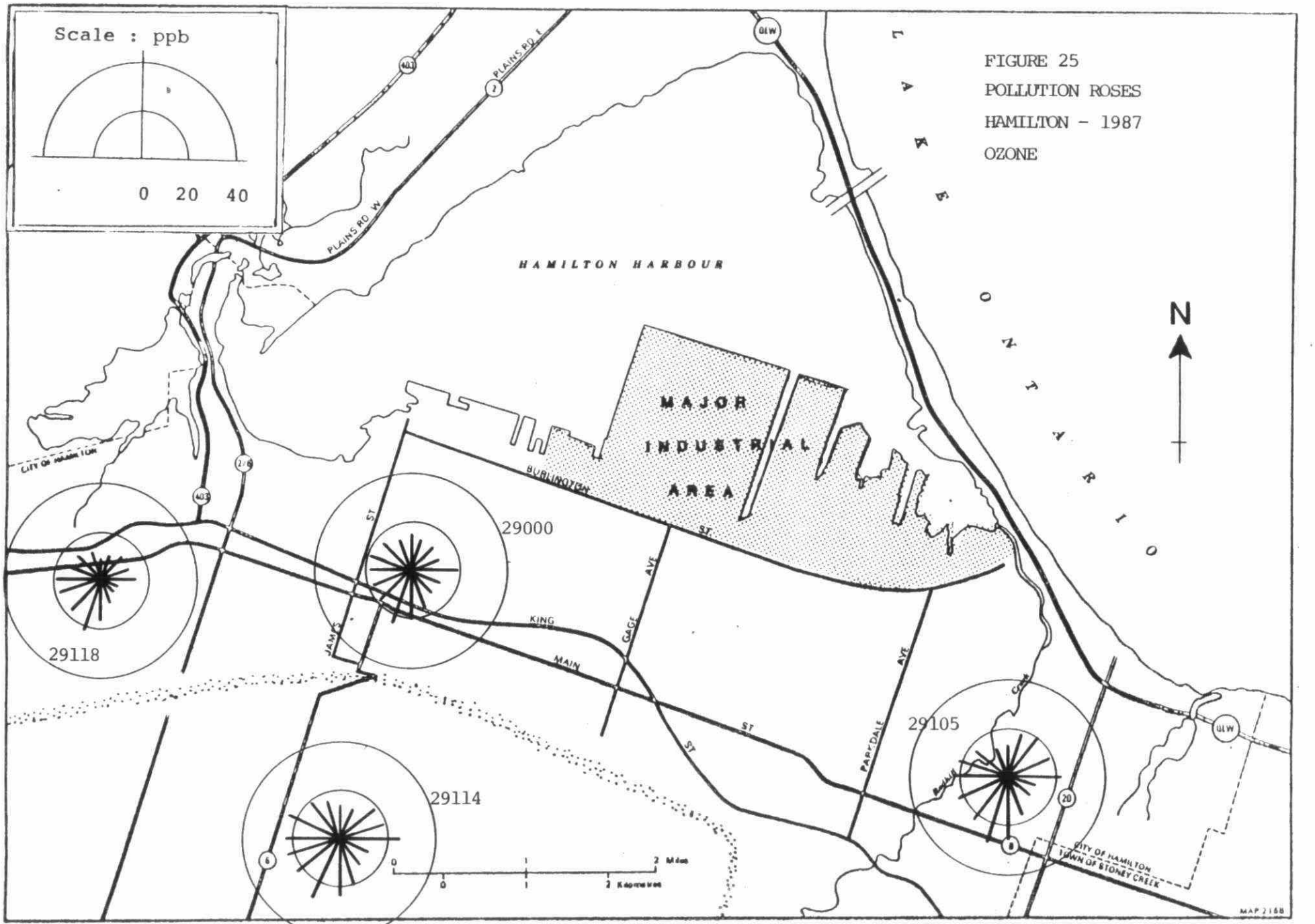
^{11} - Numeric exponent refers to number of months sampled when less than 12.
* - 29025 moved to 29000 in February 1987.

FIGURE 24

OZONE EXCEEDENCE TREND

HOURS OVER 80 PPB AT 29025/29000




Scale : ppb
0 20 40
FIGURE 25
POLLUTION ROSES
HAMILTON - 1987
OZONE
HAMILTON HARBOUR
LAKE ONTARIO
N
MAJOR INDUSTRIAL AREA
29000
29118
29114
29105
PLAINS RD E
PLAINS RD W
BURLINGTON ST
KING ST
MAIN ST
JAMES ST
GAGE AVE
PARKDALE AVE
CITY OF HAMILTON
TOWN OF STONEY CREEK
0 1 2 Miles
0 1 2 Kilometres
MAP 2168

scavenge ozone. There were a total of 23 days when at least one station exceeded the objective during the spring/summer. Winds were southwest each time and warm temperatures prevailed.

The origin of the ozone is believed to be the United States. The pollution roses in Figure 25 confirm that highest concentrations occurred under winds from the southwest quadrant. The peaks from these directions are not overly prominent because southwest winds do not automatically yield high ozone levels even during the summer. Low temperatures, lack of precursor pollutants or absence of direct sunlight all reduce ozone formation.

Ozone, hydrocarbons and oxides of nitrogen can be transported over great distances and can be augmented by local sources. However, Hamilton and other major urban areas usually experience lower ozone concentrations than their more rural surroundings during peak occurrences. In fact, the concentrations in Hamilton are among the lowest recorded in Southern Ontario, probably due to the numerous high temperature combustion sources which produce scavengers of ozone such as nitric oxide. Nonetheless, ozone and other oxidants remain a problem in the Hamilton area. Due to the complexity of oxidant formation and the long range transport phenomenon, this problem will have to be resolved on a national and international rather than local scale.

4.8 Fluoridation

This measurement is a relatively crude assessment used to determine quantities of various fluoride compounds in the ambient air. A lime coated paper is exposed to the atmosphere for one month and is then chemically analyzed for fluoride. The fluoride objectives are based on vegetation damage and for

this reason, the objective is more stringent during the growing season. For the period of April 15 to October 15, it is 40 micrograms/100 square centimeters/30 days while for the remainder of the year it is 80.

In Hamilton, the major fluoride sources are the basic oxygen furnaces used by the major steel industries which require fluorspar as a fluxing agent. In addition to these process emissions, there are other minor sources such as coal burning, since coal contains trace amounts of fluoride. A brick manufacturing plant at the base of the escarpment near Gage Park is the only non-steel industry source.

Data for 1987 are summarized in Table 12 and the yearly trend since 1970 is illustrated in Figure 26.

The trend graph shows that while levels were declining gradually during the 1980's following large reductions in concentrations which began in 1971, an upturn in concentrations was observed in both 1986 and 1987. In 1987 the increase was on average about 40% over the previous year. The reasons for this are unknown.

A contour plot of yearly averages is given in Figure 27. A ring can be drawn around the industrial area as shown. The worst station within this area recorded 9 samples above the monthly objectives. However, the 1987 Phytoxicology Assessment Survey given in the Appendix indicated that fluoride injury to silver maple foliage (a sensitive indicator species) in this area was only in very small amounts.

The most prominent individual source of airborne fluoride in the city is the Hamilton Brick Co., near Gage Park. A new monitor (29115-London/Justine) was established there in 1986 and recorded high levels above objectives. Limited 1987 data is available,

TABLE 12

FLUORIDATION RATE - 1987

ALL VALUES IN MICROGRAMS/100 SQ. CM/30 DAYS

Ontario Criteria - Apr. 15 to Oct. 15 - 40
Oct. 15 to Apr. 14 - 80

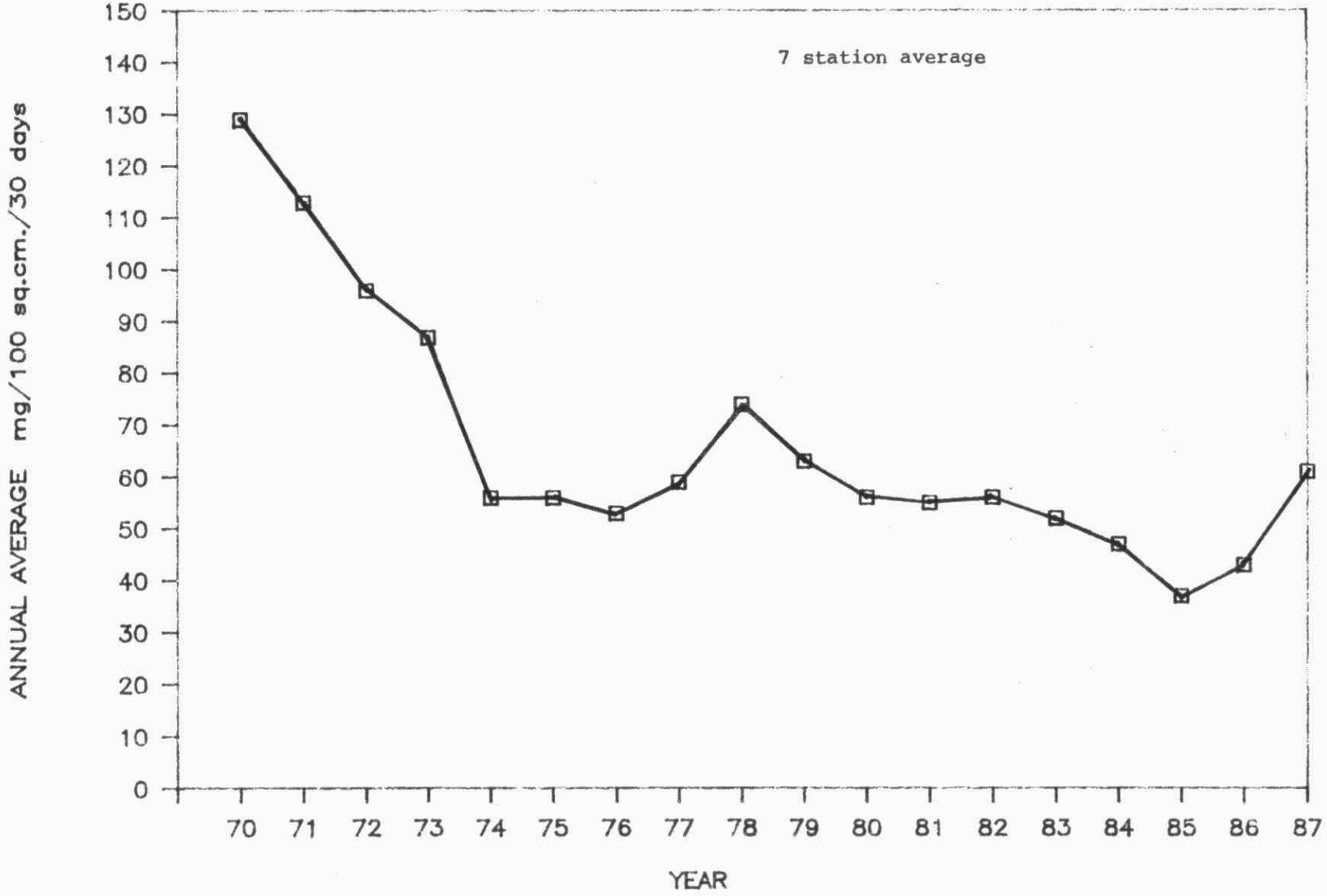
	Annual Average			Maximum	Number of Months Above Objective
	1985	1986	1987	1987	1987
29001 Hughson/Hunter	26	28	38	80	3
29012 Burlington/Wellington	25	22	40	161	2
29025 Barton/Sanford	34	40	54	95	6
29054 Beach Rd./Conrad	35	44	79	284	5
29059 Burlington/Gage	51	59	89	148	8
29062 Briarwood School/ King St. E.	44	54	64	161	5
29066 Killarney/Beach Blvd.	45	54	64	107	5
29115 London/Justine	-	269^{11}	190^{4}	319	3^{4}
29116 Dalkeith/Ottawa	-	59^{11}	94	196	9
29119 Morley/Parkdale	-	45^{11}	52	131	4
29120 Dickson/Burlington	-	64^{11}	77	201	6

11 - Numeric exponent refers to number of months sampled when less than 12.

FIGURE 26

FLUORIDATION RATE YEARLY TREND

HAMILTON 1970 – 1987



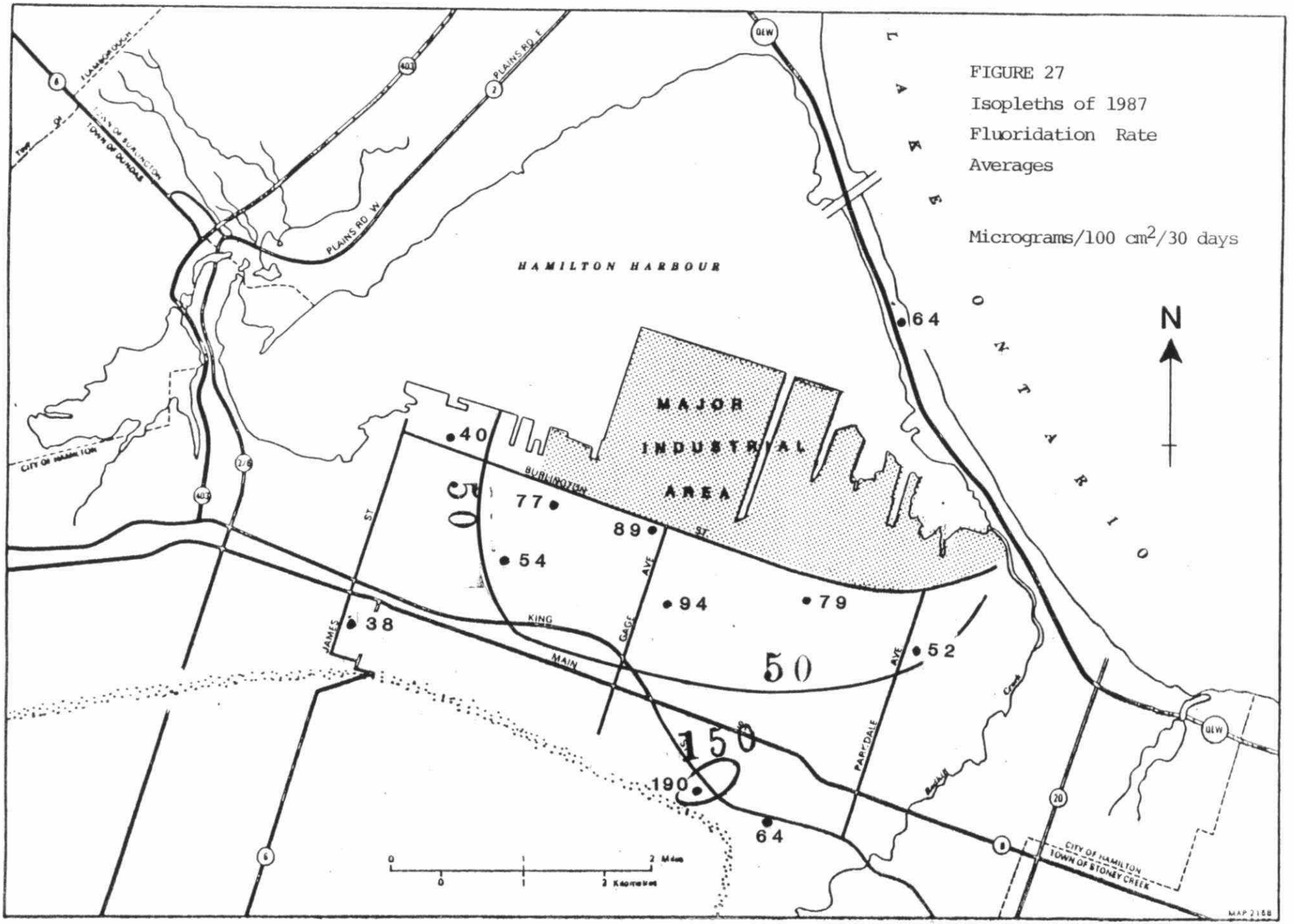


FIGURE 27
Isopleths of 1987
Fluoridation Rate
Averages
Micrograms/100 cm2/30 days
HAMILTON HARBOUR
LAKE ONTARIO
MAJOR INDUSTRIAL AREA
N
64
40
77
89
54
94
79
38
52
50
150
190
64
BURLINGTON ST
KING ST
MAIN ST
JAMES
GAGE AVE
PARKDALE AVE
PLAINS RD W
PLAINS RD E
QEW
403
CITY OF HAMILTON
TOWN OF STONEY CREEK
MAP 2188

since this survey was only intended to provide an initial estimate of concentrations.

Elevated fluoride concentrations near brick plants are common. A 1983 report undertaken jointly by the Ontario Ministries of Environment, Health and Labour concluded that "the maximum additional intake of fluoride resulting from exposure to brick plant fluoride emissions is small. It is concluded that this additional intake could be considered to fall within the normal range of fluoride intake from dietary sources and as such would not be expected to induce health effects in an exposed population" (p. 24). This report was based on measurements near a Toronto and a Brampton brick plant. Concentrations in Toronto and Brampton were higher than those measured at the Hamilton station. The company is investigating alternatives to control emissions and the Ministry will require an abatement program. Since the initial concentration levels near the plant were determined, the monitor was removed in 1987. A network of five monitors has been re-established around the plant in 1988 in order to determine trends.

Although human health concerns are not a problem, some vegetation damage in the vicinity of the plant was discovered on silver maple foliage. The Phytotoxicology Section conducted a survey of vegetation near the plant in September 1986. Light to moderate injury to sensitive vegetation (mostly silver maple) was discovered in the vicinity. Injury and fluoride concentrations in the vegetation decreased with distance from the brick plant. The maximum fluoride concentration measured was 820 ug/g, well above the guideline of 35. In contrast, the maximum fluoride level measured in the industrial area was only 60 ug/g in the regular 1987 survey.

5. MOBILE MONITORING SURVEY - 1987

At the request of the West Central Region, Mobile Air Monitoring Units #1 and #2 from the Air Resources Branch undertook an ambient air quality survey in the industrialized sector of Hamilton from September 28 to October 21, 1987.

The main aims of this survey were to determine the air quality in this area and if possible, to investigate the air quality in the vicinity of several "targetted" industries north of Burlington Street, namely; the Carbochem Tar Plant (formerly Domtar), Columbian Chemical, the Stelco and Dofasco steel mills and Canron Ltd.. The results of this survey were also to be compared with similar studies that were conducted in the fall of 1985 and 1986.

The results of the "targetted" industries follow.

Carbochem (Formerly Domtar)

Air monitoring in the vicinity of the Carbochem tar plant on Strathearne Avenue was conducted on four different days in 1987. From these data, the tar plant was found to be a source of total reduced sulphur compounds, aromatics, alkanes, indan and naphthalene.

The maximum half-hour average concentrations of total reduced sulphur compounds (TRS) measured downwind of this plant ranged up to 0.110 ppm (parts per million). In 1986, the maximum half-hour average for TRS was 0.12 ppm (i.e. similar).

The one-hour Provisional Guideline for total reduced sulphur (0.027 ppm) is not strictly applicable to this study since the guideline was developed for and applies to kraft pulp mills. However, the maximum half-hour average of 0.110 ppm measured

downwind of this tar plant did exceed the pulp mill guideline value. A request has been forwarded to the Ministry's Standards Development Unit to develop a general guideline for TRS.

The average total organic concentration was found to be approximately 600 ug/m^3 in 1987. In 1986, this average concentration was 800 ug/m^3. In 1987, the alkane and aromatic fractions accounted for 15 and 82% respectively. In 1986, these fractional groups comprised 13 and 74% respectively.

Except for naphthalene, none of the VOCs were detected in concentrations that exceeded applicable Ministry of the Environment Air Quality Standards, Criteria, Guidelines or Provisional Guidelines. In 1987, half-hour concentrations of naphthalene ranged up to 61 ug/m^3 downwind of this tar plant. This compares to the maximum of 330 ug/m^3 measured in 1986. The Provisional Guideline for naphthalene is 36 ug/m^3. Thus, the standard was exceeded in 1987, however, it was exceeded on only one of four monitoring days downwind of the tar plant. Thus, a significant improvement in this contaminant was recorded.

Dofasco

Sampling downwind of Dofasco was limited to a brief period on one day. Due to heavy rainfall no VOC cartridge sampling was performed but the common contaminants were measured and the only pollutant of concern was NOx, which measured up to .27 ppm, above the standard of .25 ppm. TRS levels were low, only up to .006 ppm. The concentrations were similar to those measured in the 1986 survey.

Stelco

In 1987, monitoring was conducted on one day downwind of Stelco. From this air quality data, the only pollutants of concern were the reduced sulphur compounds which measured up to .013 ppm, above the odour threshold for hydrogen sulphide but below the provisional TRS guideline of .027 ppm (for kraft pulp mills only).

For the VOCs detected during the 1987 survey, the average total organic concentration determined was only from 76 to 127 ug/m^3. Only 15 or 16 different VOCs were detected in these samples. Samples acquired downwind of Stelco in 1986 showed total VOC concentrations up to 232 ug/m^3.

None of the applicable Ministry of the Environment Air Quality Standards, Criteria, Guidelines or Provisional Guidelines were exceeded by the contaminants measured downwind of this source. In 1986, significant concentrations of NOx up to .47 ppm were detected downwind of Stelco, above the standard of .25. However, in 1987 the maximum NOx measured was only .14 ppm, although less sampling was conducted near Stelco than in 1986.

Canron (Pipe Division)

Complaints of odours and dust fallout at neighbouring industries prompted air monitoring by the MAMU vans on two days in 1987 near the Canron Pipe Division at Burlington St. and Kenilworth Ave. A strong non-sulphurous organic odour was present at times. Concentrations of the common contaminants (CO, NOx, SO_2, TRS etc.) were within all guidelines downwind of Canron. Total organic concentrations ranged up to 1432 ug/m^3 of which, alkanes, cycloalkanes, aromatics and chlorinated organics comprised 34%, 7%, 47% and 10%

respectively on average. The more dominent organics were dichloromethane, benzene, toluene, 2-methylheptane, octane ethylbenzene and xylenes. The above compounds could have accounted for some of the odour, but all individual concentrations were below standards and guidelines.

Columbian Chemicals

From the one day of monitoring in the vicinity of Columbian Chemical during the 1987 survey, low concentrations were measured and the results were found to be characteristic of an urban environment. The lower alkanes and carbon monoxide were the dominant contaminants measured. Similar results were found during the 1986 survey. Little if any contribution directly attributable to Columbian could be made with respect to the pollutants measured.

No applicable Air Quality Standards, Criteria, Guidelines or Provisional Guidelines were exceeded or even approached by the contaminants measured downwind of this source in 1986 or 1987.

Air Quality City-Wide During Inversion Conditions

On October 16, a strong inversion was present and the Hamilton Air Pollution Index would eventually reach 35. This was the second of the two such incidents (over 31) which occurred during the year. The two MAMU vans were directed to monitor air quality at various locations across the city.

Pier 24/25 - Beach Strip

Winds were easterly, (i.e. upwind of the industrial area) and elevated levels of NOx were measured ranging from .50 to .63 ppm, above the half hour standard of .25. VOC sampling showed that the

total organic concentration was 417 ug/m^3 with the alkane and aromatic fractions comprising 69% and 24% respectively. The higher percentage alkane contribution (especially the low-boilers propane through hexane) confirmed that vehicle emissions from the QEW were the source of the contaminants.

J. I. Case Plant (formerly Harvester)

This site near the shore of Hamilton Harbour adjacent to Stelco was recording light westerly winds unlike all other areas which were showing east winds. A land/lake air circulation was taking place at this site. Some intermittent odours were detected, but in general the odour was characteristic of vehicle emissions. None of the common contaminants exceeded standards, The VOC sample showed total organic concentrations of 467 ug/m^3 of which the alkanes and aromatics comprised 54% and 32% respectively. Again, the low boiling alkanes dominated, indicating vehicle traffic was a main source.

Sam Lawrence Park - Mountain Brow

Winds here were light and easterly and the most dominant contaminant was NOx which recorded .49 ppm, above the standard of .25. TRS reached .011 ppm above the odour threshold of .010. The VOC sample showed a total organic concentration of 627 ug/m^3, of which alkanes accounted for 62% and aromatics 30%. Vehicle traffic was the main source of the contaminants except for the TRS which was from the industrial zone.

McMaster University - Main Street West

Winds were light and easterly and lower concentrations were measured than at the other sites, well below all relevant standards or guidelines. Total organic concentrations were

441 ug/m^3 comprised mostly of alkanes (63%) and aromatics (20%).

In summary, the inversion sampling by the MAMU vans indicated that the main source of gaseous emissions in the city was vehicle traffic. The readings would of course be influenced by distance from major roadways.

6. Air Monitoring Near Steetley Industries

In addition to the network in the City of Hamilton, the Ministry has been monitoring airborne dust levels near Steetley Industries near Greensville in the Town of Flamborough since 1974. Four dustfall jars have been in place continuously since that time, and two additional jars were added in 1982 as the quarry expanded. In addition, beginning in 1986, hi-vol sampling for suspended particulates was undertaken at the Westfield Academy on Ofield Road South, just northeast of the quarry at station 29111. A second hi-vol (29112), was installed in the village of Greensville in mid-1987. A map of the station locations is given in Figure 28.

The 1987 suspended particulate data at station 29111 - Westfield, indicate a sometimes severe localized problem with airborne dust. The annual geometric mean of 89 ug/m^3 was well above the yearly objective of 60 and 17 out of 59 samples exceeded the daily objective of 120. All data is summarized in Table 13.

Further away in the village of Greensville at station 29112, the levels were not as severe. Although only the last half of the year was sampled, the geometric mean was well below the annual objective and only one sample out of 29 exceeded the daily objective.

Dustfall levels (also Table 13) in 1987 improved from 1986 at 4 of the 6 stations. The improvement at one of these stations, 29074, may have been partly due to the paving of Ofield Road South during the summer. All samples from August on met the monthly objective at this station. Concentrations at station 29075 on Harvest Road have also improved markedly. Station 29073 at a restaurant on Hwy. 5 just northeast of the quarry continued to yield the highest concentrations, almost double the other five stations, and eight samples exceeded the

FIGURE 28
Map of Sampling Station Locations
Near Steetley Industries
Flamborough

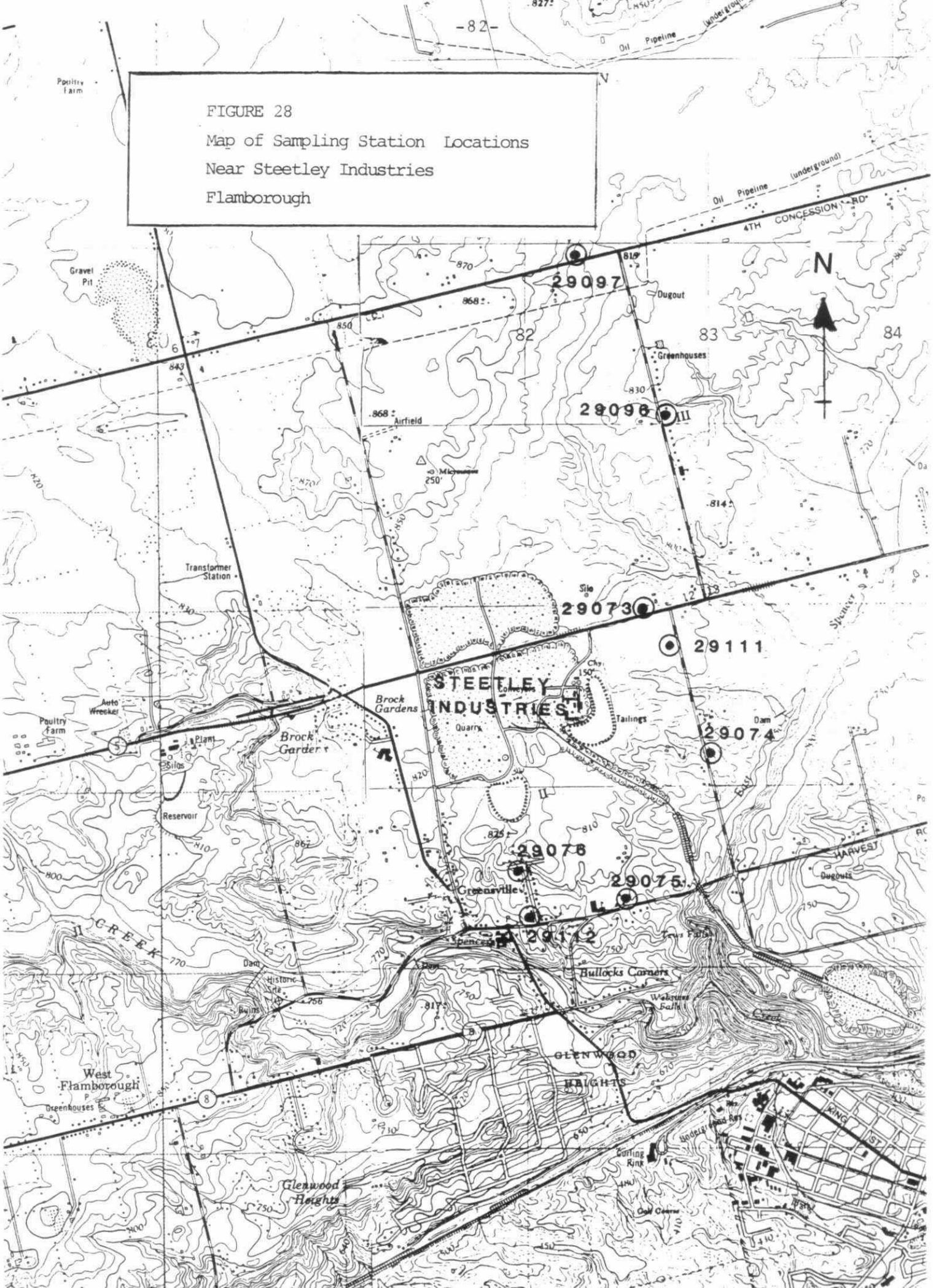


TABLE 13

SUMMARY STATISTICS - GREENSVILLE

PARTICULATES NEAR STEETLEY QUARRY

SUSPENDED PARTICULATES - micrograms per cubic metre

ONT.OBJECTIVES: 120 (24 hour)
60 (annual geo.mean)

STATION	GEOMETRIC MEAN 1985	1986	1987	1987 MAXIMUM 24 HR	NO.OF SAMPLES	NO.TIMES OVER OBJECTIVE(1987) 24 HR	1 YR
29111 OFIELD S/HWY 5	-	100	89	393	59	17	1
29112 HARVEST/WESITE	-	-	39	241	26	1	0

DUSTFALL - grams/square metre/30 days

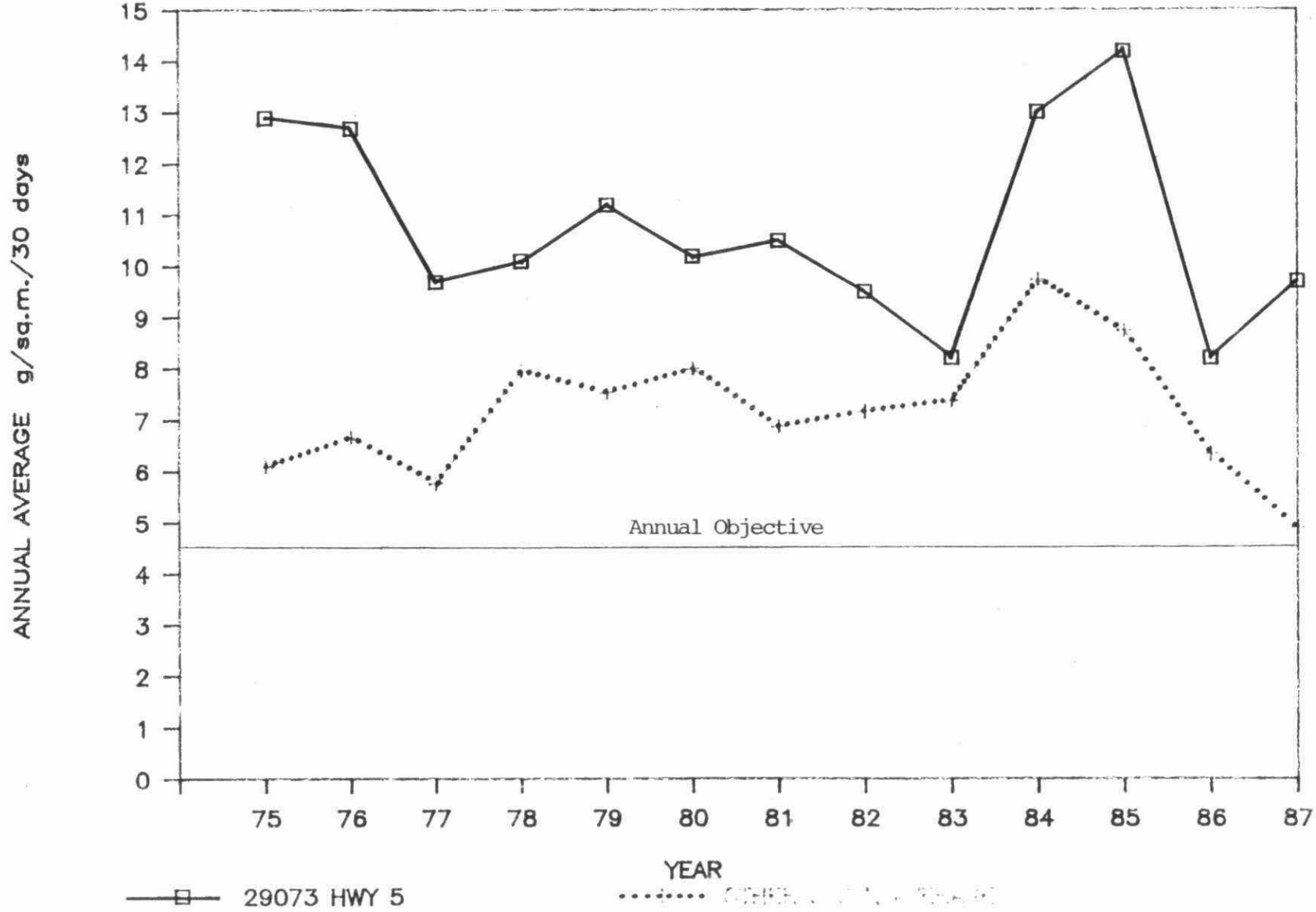
ONT.OBJECTIVES : 7.0(1 MONTH)
4.5(ANNUAL AVERAGE)

STATION	ANNUAL AVERAGE 1985	1986	1987	1987 MAXIMUM 1 MONTH	NO.MONTHS OVER OBJECTIVE 1985	1986	1987
29073 - HWY 5/OFIELD	14.2	8.2	9.7	16.2	11	9	8
29074 - OFIELD S	11.2	7.2	5.2	8.9	7	6	3
29075 - HARVEST RD	8.6	6.5	4.7	12.6	10	5	2
29076 - MELDRUM/WESITE	6.4	5.3	4.8	6.9	3	3	1
29096 - OFIELD N	6.2	4.8	5.2	10.8	4	0	3
29097 - 4TH CONCESSION	5.2	4.1	3.9	10.0	2	1	2

FIGURE 29

DUSTFALL YEARLY TREND

GREENSVILLE AREA NEAR STEETLEY QUARRY



monthly objective. There is some concern that this restaurant's unpaved parking lot is contributing to the readings. To ascertain this, a second jar has been located close by in 1988, but removed from the lot.

Figure 29 gives the yearly trend of dustfall dating back to 1975 for the old four established locations. The restaurant station (29073) trend is given together with the combined average of the other three locations. The latter curve shows an improvement since 1984. The restaurant curve does likewise except for an upturn in 1987.

In January 1987, the Steetley Quarry installed a new electrostatic precipitator to control their #1 and #3 kilns. The emissions from these kilns were also directed into a single tall stack, eliminating a shorter stack and thus providing better dispersion of remaining process emissions. The dustfall data seemed to indicate this had a positive effect.

However, the suspended particulate data at the Westfield Academy indicate major emission problems remain and citizen complaints of dust fallout have continued. The major remaining dust source at Steetley are likely the dry fines plant, and various fugitive dust sources such as stock piles, roads, portable crushers, and a large stone feed pile for the #3 kiln. The latter pile is located only about 150 metres from the Westfield Academy hi-vol site. Additional controls on fugitive sources have been brought into use in 1988.

7. DISCUSSION

The main air pollution problem in Hamilton, apart from occasional odours and dust fallout in the industrial area, is short-term pollution build-ups during the spring and fall due to the presence of temperature inversions. The sources of the pollution are both vehicle traffic and industry.

During 1987, particulate levels remained unchanged at most monitoring stations. The Air Pollution Index (API) reached the advisory level of 32 on two occasions, compared to five times in 1986, all during inversion conditions. The city's unique topography makes it very susceptible to inversions during which times pollution build-ups are unavoidable, and therefore, such incidents will recur in the future.

The 1987 Phytotoxicology Section's annual chemical analysis of silver maple foliage (attached in appendix) indicated that fluoride, boron and iron values were elevated in proximity to the industrial area and decreased with distance, confirming the industries as a source(s) of these elements. Boron and fluoride exceeded background values in 1987 at two stations located closest to the industries. Concentrations of iron and fluoride were generally higher than in 1986 confirming the increase measured by the fluoride candles in the regular network. Boron concentrations remained unchanged. Lead and sulphur values were well within their respective normal concentration ranges, although the concentrations of these elements were frequently higher near the industrial complex. Concentrations of most of the measured parameters have generally decreased since the phytotoxicology surveys began in Hamilton in 1973.

The Air Resources Branch mobile van survey in 1987 confirmed that naphthalene and total reduced sulphur compounds were a

potential environmental problem in the industrial sector of Hamilton. Half-hour average concentrations ranging up to 61 micrograms per cubic meter (ug/m^3) of naphthalene were detected downwind of the Carbochem (formerly Domtar) tar plant on one of four monitoring days, above the Provisional Guideline of 36 ug/m^3. The naphthalene levels were a distinct improvement over similar measurements made in 1985 and 1986.
Half-hour concentrations of total reduced sulphur compounds ranging up to 0.110 ppm were also detected downwind of the Carbochem plant. The Ministry Provisional Guideline of 0.027 ppm for for total reduced sulphur compounds was developed specifically for the Kraft Pulp Mill industry and therefore is not directly applicable to these data, but it is worth noting that this value was exceeded. A more general guideline has been requested.

Mobile air monitoring was also performed downwind of Stelco, Dofasco, Canron Pipe Division and Columbian Chemicals. Concentrations of contaminants measured met all standards, criterial or guidelines, however, odours were present occasionally close to these sources.

The mobile survey also carried out measurements city-wide during an inversion on October 16 when the API reached 35. Data indicated that the primary source of gaseous contaminants at all locations was vehicle traffic.

Ambient particulate levels continue to improve as industrial emissions decrease and further small improvements can be expected. However, major reductions in airborne particulate levels can no longer be expected through control of stack emissions alone.

Dustfall levels throughout the city decreased slightly at most locations in 1987, but overall have improved little since 1970 despite major decreases in industrial process emissions and

efforts by the larger industries to control fugitive dust by such techniques as the use of chemical sealants, road paving, road washing and landscaping. This indicates that other pollution sources on which no emphasis has yet been placed will also require control wherever possible. These sources can be both industrial and non-industrial in nature, such as blowoff from unpaved areas, excavation, construction, demolition, road traffic and stock piles and related materials handling. Further efforts to reduce fugitive dust emissions should be made by both City and industry.

The Hamilton air monitoring network has recently been expanded because of the introduction of the new Air Quality Index.

A new telemetry system allows for immediate access to data, both in Toronto and in the Hamilton office and permits remote control and maintenance of instruments, all resulting in a more efficient monitoring program.

A new station was located closer to downtown in 1987 at Elgin and Kelly Streets. This station measured the Air Pollution Index in place of the Barton/Sanford location during 1987. All of the Barton Street station's automated instruments were transferred to Elgin/Kelly. However, Barton still operates on a reduced scale for several key parameters. The new station was more representative for the Hamilton area as a whole.

Now that the new telemetry system has been installed and is properly functioning, the new Air Quality Index (AQI) has been added to the old Air Pollution Index.

The new AQI is a function of six different pollutants, which form up to eight separate subindices. The highest hourly sub-index becomes the AQI. Concentrations of sulphur dioxide,

soiling index, carbon monoxide, nitrogen dioxide, total reduced sulphur and ozone are all individually converted to the old scale of index numbers (although not all AQI stations measure all six pollutants and all eight sub-indices). The advisory or alert levels remain the same as previously-32, 50, 75 and 100. The old API has been retained as one sub-index and will continue to be used for industrial action requests should the API reach 32 or higher.

In Hamilton, four separate AQIs are being reported for the east, west, mountain and the new downtown station at Elgin/Kelly. The need for more than one index station in Hamilton has been apparent for some time as air quality can vary widely throughout the city at any given time.

The intent of the new index is to better inform the community about day to day air quality.

8. References

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APPENDIX 1

PHYTOTOXICOLOGY ASSESSMENT SURVEY IN THE HAMILTON AREA, 1987

Air Resources Branch
Phytotoxicology Section

By: Dr. W.D. McIlveen

Date: April 1988

ARB No.: ARB-090-88-Phyto

Phytotoxicology Assessment Survey in the Hamilton Area, 1987

Introduction

Since 1970, the Phytotoxicology Section of the Ontario Ministry of the Environment has conducted annual surveys of vegetation and soils of the Hamilton area. The purpose of these surveys has been to document the condition of vegetation species and their accumulation of airborne contaminants emitted from the heavy industrial complex located on the south shore of Hamilton Harbour. The present report summarizes the results obtained from the survey conducted in 1987 in relation to earlier investigations.

Survey Outline

The survey in its present format was established in 1973. At that time, eleven permanent sampling stations were established as indicated in Table A. In 1986, two additional stations were added on the north shore of Hamilton Harbour in order to assess the impact of emissions which might traverse the harbour area. All stations are shown in Figure 1. In 1987, there had been extensive pruning of street trees in Hamilton and the tree at Station 7 was no longer available. A sample was collected from a tree located nearby at Harvey Street.

On September 9, 1987, at each established station foliage samples of silver maple (Acer saccharinum) were collected for chemical analysis. Visual observations of foliage condition were also made at this time.

The samples were brought to the Phytotoxicology laboratory for processing. The samples were oven-dried, ground in a Wiley-mill and stored in glass bottles. They were then analyzed for fluoride, boron, iron, sulphur and lead. All analyses were performed by the Inorganic Trace Contaminants Section of the Ministry of the Environment Laboratory, Resources Road, Toronto.

TABLE A

Station No.	Location	Direction*
1	Beach Blvd. at Burlington Canal	4.4 km NE
2	Beach Blvd. at Renfrew	3.5 km NE
3	Beach Blvd. at former toll booth	3.4 km E
4.	Mead and Dunn Streets	5.0 km SE
5	Craigmiller and Rosslyn Streets	2.3 km S
6	Burlington and Gage Streets	1.3 km S
7**	Minto and Bristol Streets	2.3 km SW
8	Eastwood Park	3.2 km W
9	Charlton and Dundurn	7.2 km SW
10	Oakwood Place	9.3 km SW
11	West and Baldwin	12.2 km SW
12	Brighton Beach Park	3.3 km WNW
13	Lasalle Park	4.0 km NNW

*Distance and direction from approximate centre of steel making complex.

** Relocated to Harvey and Stirton Streets in 1987.

Visual Observations

Injury to the maple foliage in 1987 was restricted to light to moderate terminal necrosis at Stations 5, 6 and 7 nearest to the industrial complex. Surficial particulate was conspicuous on foliaged collected at Station 6. The details of each observation are indicated in Table 1.

Chemical Analysis Results

The results of the chemical analyses are presented in Tables 2 to 6.

Fluoride:

Fluoride concentrations in silver maple foliage collected at the sampling stations are shown in Table 2. Prior to 1985, elevated fluoride values (>35 ug/g F) were regularly encountered at a number of stations within or near the industrial area. Foliage collected at those stations nearest the steel mills contained the highest amounts of fluoride. Foliage samples collected at Station 6 exceeded the limit of background concentrations for fluoride in every year from 1973 to 1985. The remote stations (Stations 9, 10 and 11) all showed background fluoride values except Station 9 in 1977.

The years of higher values included 1976, 1977 and 1979 and to a lesser extent 1973. The highest value measured was 335 ug/g F in the unwashed sample collected in 1977 at Station 6. By contrast the highest value found in 1986 was 31 ug/g F at this same station. Further, normal background concentrations were not exceeded in 1986. In 1987, fluoride concentrations were higher than those of 1986 at all stations except Station 8. The largest increases were found at Stations 5 and 6 where 61 and 60 ug/g F were recorded. Both of these are above normal background limits for fluoride in urban foliage while the limit of 35 ug/g F was matched at Station 7. In general, the fluoride concentrations were similar to those found in the period between 1981 and 1985.

Boron:

The concentrations of boron measured in the samples are presented in Table 3. Until 1986, the upper limit of background concentration had only ever been exceeded at Stations 5 and 6 which lie within the industrial zone. In 1986, boron values in samples collected at Station 6 (280 ug/g B) exceeded the background concentration limit of 175 ug/g B. Not only were these the highest values of any stations in 1986, but they were also the highest values recorded since 1977 at this location. Samples collected in 1987 exceeded the background

concentration limit at Station 6 but also at Station 7. Although the tree sampled in 1987 at Station 7 was located only at short distance from the tree that was sampled in previous years, it is possible that the fact that different trees were sampled could explain the higher value for 1987. At all other stations, the boron concentrations were generally similar to those in previous collection.

Iron:

The iron concentrations in the maple foliage samples are indicated in Table 4. The data show that the foliage contained above normal (> 1000 ug/g Fe) consistently at Station 6 located nearest to the steel mill complex. The value of 430 ug/g Fe recorded in 1987 was the lowest ever encountered at this station. Iron concentrations increased in comparison with 1986 values at all stations except 6,7, and 8 in 1987. At no station did the iron concentration exceed the upper limit of normal for iron in urban foliage. The lowest iron concentrations were measured in samples collected to the south west (towards Dundas) or on the north shore of Hamilton Harbour.

Lead:

The lead concentration of vegetation is shown in Table 5. Since 1980, no samples of maple foliage collected in the Hamilton area contained lead in concentrations considered to be above that of urban background. Up to 1980, elevated lead levels (greater than 60 ug/g Pb) were found at Stations 2, 3 and 6 on two or more occasions. Lead values found in 1986 were generally lower than in previous years at corresponding locations perhaps reflecting the washing of foliage by the heavy rainfall during 1986. Concentrations of lead measured in samples in 1987 were similar to those encountered in recent years; however, the concentrations continued to decline at Station 6 which previously had been the most heavily contaminated site.

Sulphur:

The sulphur concentrations in the silver maple foliage are presented in Table 6. The concentrations varied widely from year to year at any given station. The sulphur concentrations in samples collected in 1986 were lower than in 1985 at all stations except Stations 7 and 8. At most stations, the sulphur content of the samples were essentially similar to those encountered in 1986. The exceptions were at Stations 3,6 and 9 where the inceases were 0.07 to 0.13% above 1987 values; although no value exceeded any previous high concentration for sulphur. No sample collected in this survey has ever exceeded the upper limit of normal for sulphur (0.40% S) in urban vegetation.

Summary

The annual surveillance program to determine whether emissions from the industrial complex at Hamilton were affecting vegetation was continued in 1987. Injury to silver maple foliage was restricted to light to moderate terminal necrosis at three stations closest to the industrial complex. From the chemical analyses obtained, it was shown that boron and fluoride values were elevated in proximity to the industries. Each element exceeded background concentration at 2 locations each. Iron concentrations increased over 1986 values, especially to the east and northeast of the industrial complex. Lead and sulphur concentrations were generally similar to those of previous years.

When the situation is viewed from an overall perspective, it would appear that conditions have reached a relatively stable situation which is substantially improved over early years of this survey. There is some year to year variation depending upon the element and also the amount of rainfall prior to sample collection. In view of this, consideration will be given to reducing the frequency of this survey in favour of other specialized studies yet to be determined.

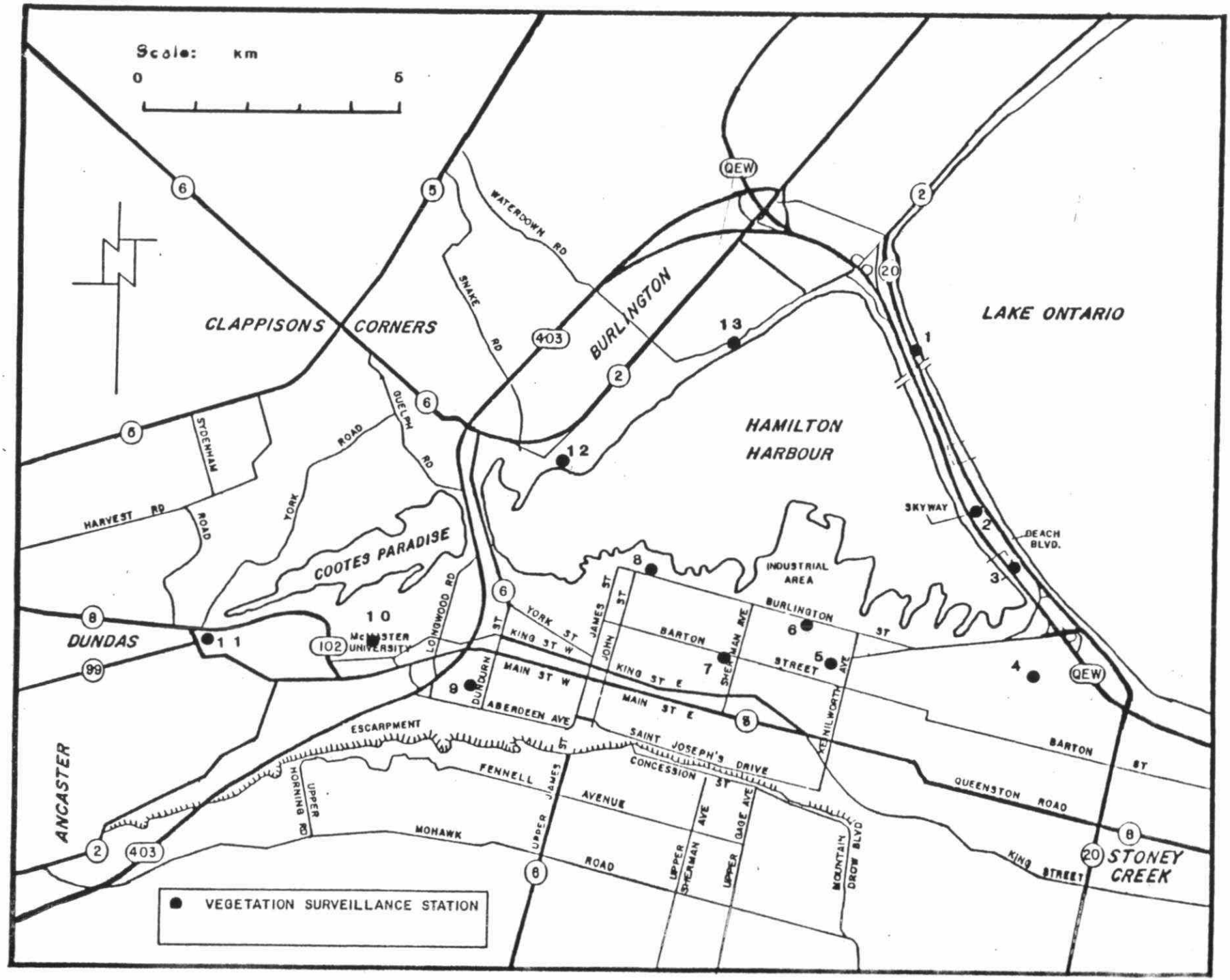

Figure 1 Vegetation monitoring stations in the Hamilton area

Table 1: Conditions of Foliage of Silver Maple Samples Collected at Sampling Stations in the Hamilton Area - Sept. 9, 1987

Station Number	Conditions
1	Tree terminal necrosis; light blister mite
2	Trace to light terminal necrosis, moderate anthocyanotic mottle
3	Trace terminal necrosis
4	Trace terminal necrosis
5	Light terminal necorsis, moderate intercostal anthocyanosis
6	Light moderate terminal necrosis, slight black residue
7	Light marginal necrosis
8	Trace marginal necrosis
9	Trace terminal necrosis
10	Trace terminal necrosis
11	Trace terminal necrosis
12	Healthy
13	Trace terminal necrosis, light mite injury

Necrosis = dead tissue

Anthocyanosis = red or purple discoloration

TABLE 2 - Fluoride Concentrations (µg/g, dry wt.) in Not Washed Silver Maple Foliage Collected in Hamilton, 1973-1987.

Station No.	Location* km	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	4.4 NE	32	23	19	114	35	21	56	28	23	22	20	29	28	4	14
2	3.5 NE	130	32	32	96	97	29	112	45	29	51	15	23	21	16	26
3	3.4 NE	330	61	167	273	179	75	222	67	36	61	34	37	-	11	30
4	5.0 SE	80	30	26	107	37	20	49	32	25	40	14	21	23	10	16
5	2.3 S	65	68	29	144	110	46	106	212	38	42	26	28	24	11	61
6	1.3 S	177	181	92	243	335	111	203	164	92	42	120	71	70	31	60
7	2.3 SW	52	72	42	110	141	55	88	32	40	62	61	24	26	26	35
8	3.2 W	45	35	38	46	73	48	49	15	28	36	17	14	21	13	12
9	7.2 SW	17	21	13	31	40	14	30	10	23	20	11	13	7	7	10
10	9.3 SW	15	12	3	15	12	9	21	3	22	18	6	9	5	5	6
11	12.2 SW	15	13	-	26	31	6	15	5	10	12	6	9	4	2	5
12	3.3 WNW	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4
13	4.0 NNW	-	-	-	-	-	-	-	-	-	-	-	-	-	3	6

Contaminant Guideline: Foliage, NW - 35 ug/g fluoride

*Relative to centre of steel-making complex.

TABLE 3 - Boron Concentrations (µg/g, dry wt.) in Not Washed Silver Maple Foliage Collected in Hamilton, 1973-1987

Station No.	Location* km	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	4.4 NE	113	93	108	107	139	83	120	91	81	66	51	50	48	68	66
2	3.5 NE	106	92	94	82	-	82	70	76	64	46	46	67	54	66	91
3	3.4 E	136	113	82	95	110	71	87	72	70	65	62	75	-	54	86
4	5.0 SE	82	69	75	63	85	75	53	59	58	46	48	55	59	56	45
5	2.3 S	118	124	309	200	-	239	109	131	119	125	150	96	130	97	131
6	1.3 S	158	139	179	174	290	163	230	138	186	246	217	275	110	280	183
7	2.3 SW	148	111	154	116	125	107	125	156	128	104	104	127	70	130	280
8	3.2 W	60	79	81	71	78	54	45	57	106	88	84	89	72	59	57
9	7.2 SW	84	79	90	74	78	90	68	82	60	47	51	42	67	63	70
10	9.3 SW	50	63	61	65	46	44	62	49	36	39	42	50	40	38	46
11	12.2 SW	74	62		76	97	39	48	63	41	50	45	64	40	57	60
12	3.3 WNW	-	-	-	-	-	-	-	-	-	-	-	-	-	60	56
13	4.0 NNW	-	-	-	-	-	-	-	-	-	-	-	-	-	45	41

Contaminant Guideline: Foliage, NW - 175 ug/g boron

*Relative to centre of steel-making complex.

TABLE 4 - Iron Concentrations (µg/g, dry wt.) in Not Washed Silver Maple Foliage Collected in Hamilton, 1977-1987.

Station No.	Location* km	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	4.4 NE	670	512	987	585	424	566	596	700	950	260	470
2	3.5 NE	1390	548	1110	780	711	679	438	640	690	380	800
3	3.4 E	1840	1010	2117	970	841	1160	987	1040	-	260	830
4	5.0 SE	620	395	743	715	489	423	377	410	630	270	450
5	2.3 S	1200	458	1030	435	587	368	510	320	550	370	660
6	1.3 S	2370	1370	2467	500	020	2100	1760	2400	2800	1400	430
7	2.3 SW	1700	502	1066	690	880	682	450	450	680	840	620
8	3.2 W	1130	558	977	610	628	685	522	340	540	560	470
9	7.2 SW	630	190	480	260	224	416	199	220	300	160	200
10	9.3 SW	350	165	340	430	94	159	120	180	210	110	170
11	12.2 SW	403	160	397	200	137	104	151	130	200	93	160
12	3.3 WNW	-	-	-	-	-	-	-	-	-	89	110
13	4.0 NNW	-	-	-	-	-	-	-	-	-	91	140

Contaminant Guideline: Foliage, NW - 1000 ug/g iron

*Relative to centre of steel-making complex.

TABLE 5 - Lead Concentrations (µg/g, dry wt.) in Not Washed Silver Maple Foliage Collected in Hamilton, 1973-1987.

Station No.	Location* km	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	4.4 NE	22	20	9	32	19	15	20	14	10	12	13	13	13	7	4
2	3.5 NE	72	64	21	46	49	26	42	14	20	15	10	10	11	7	9
3	3.4 E	272	57	34	75	53	33	32	14	20	18	17	13	-	5	12
4	5.0 S	55	38	19	42	25	16	50	14	14	12	12	11	13	5	7
5	2.3 S	35	35	11	27	33	20	24	12	13	11	8	8	10	7	8
6	1.3 S	79	03	72	86	29	43	67	64	23	30	22	26	32	19	15
7	2.3 SW	41	38	7	30	40	16	28	12	15	13	8	8	9	10	6
8	3.2 W	50	40	21	38	35	30	32	18	16	14	8	6	7	6	5
9	7.2 SW	26	25	5	29	24	24	18	10	6	11	6	7	6	2	4
10	9.3 SW	24	24	4	27	17	8	13	6	3	6	5	3	3	2	2
11	12.2 SW	27	20	-	28	21	10	21	11	6	5	7	5	4	3	3
12	3.3 WNW	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	2
13	4.0 NNW	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2

Contaminant Guideline: Foliage, NW - 60 ug/g lead

*Relative to centre of steel-making complex.

TABLE 6 - Sulphur Concentrations (µg/g, dry wt.) in Not Washed Silver Maple Foliage Collected in Hamilton, 1978-1986.

Station No.	Location* km	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	4.4 NE	0.17	0.29	0.18	0.2	0.20	0.14	0.15	0.18	0.17	0.16
2	3.5 NE	0.13	0.19	0.16	0.2	0.13	0.12	0.13	0.19	0.14	0.14
3	3.4 E	0.24	0.34	0.21	0.2	0.26	0.19	0.22	-	0.13	0.20
4	5.0 SE	0.21	0.23	0.20	0.2	0.19	0.18	0.20	0.22	0.19	0.18
5	2.3 S	0.24	0.20	0.16	0.2	0.17	0.17	0.12	0.15	0.12	0.16
6	1.3 S	0.21	0.29	0.26	0.4	0.39	0.25	0.25	0.24	0.18	0.28
7	2.3 SW	0.27	0.29	0.20	0.2	0.20	0.19	0.16	0.15	0.18	0.14
8	3.2 W	0.17	0.22	0.17	0.2	0.23	0.18	0.20	0.16	0.20	0.18
9	7.2 SW	0.23	0.25	0.24	0.2	0.25	0.15	0.10	0.22	0.11	0.24
10	9.3 SW	0.17	0.21	0.20	0.2	0.18	0.15	0.16	0.19	0.14	0.16
11	12.2 SW	0.11	0.20	0.15	0.1	0.15	0.113	0.13	0.15	0.12	0.13
12	3.3 WNW	-	-	-	-	-	-	-	-	0.15	0.15
13	4.0 NNW	-	-	-	-	-	-	-	-	0.17	0.14

Contaminant Guideline: Foliage, NW - 0.4% sulphur

*Relative to centre of steel-making complex.

RE2479-TAB